DENTAL MATERIA MEDICA THERAPEUTICS

AND

PRESCRIPTION WRITING

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TO

THE MEMORY OF

WILLIAM T. G. MORTON, M.D.

WHO FIRST

MADE KNOWN SURGICAL ANESTHESIA BY

ETHER

AND TO WHOM THE

PROFESSIONS OF MEDICINE AND DENTISTRY, AND THE WORLD, OWE

A DEBT OF PERPETUAL GRATITUDE,

THIS VOLUME

IS DEDICATED

PREFACE TO FOURTH EDITION.

WHILE progress in medical science as applied to dentistry has required a thorough revision of the text, the original aim of the author to adapt the book particularly to the needs of the dental student, has been adhered to. The chapters on Analgesia and Anesthesia have been largely rewritten, also the article on Syphilis, and a new chapter on Animal Drugs has been added, all of which necessitated enlargement by twenty-five pages. Doses have been generally included in the text, the average U. S. P. dose being employed for official substances, while the range of permissible dosage for all internal drugs is given in the Index of Drugs.

The author expresses his appreciation of the great assistance rendered by his friend, the late William H. Lane, B.S., M.D., D.D.S., who carefully revised the chapters on Local Remedies.

The courtesy and patience of the publishers is likewise acknowledged, since much delay on the author's part in completing the revision was occasioned by a period of ill-health.

E. H. L.

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DENTAL MATERIA MEDICA, THERAPEUTICS AND PRESCRIPTION WRITING.

PART I.

INTRODUCTION.

The need of a book on Materia Medica and Therapeutics, prepared especially for the specialist in dentistry, indicates a certain distinctness of practice that does not apply to other specialties. The general text-book on this branch is all that is wanted by the general surgeon, the ophthalmologist, the gynecologist, and in fact by all specialists whose preparation includes a complete medical course of study. Whether we regard the condition as normal or not, the fact is apparent that the practice of dentistry today has too little in common with general medicine. This is likely to be true to a degree for the future also, even though the tendency now is to broaden the curriculum of dental colleges. The relation of mouth conditions to the health of the whole body has in recent years assumed an importance that calls for a broader training of the dental specialist, so that he may be able to stand upon common ground with the physician in solving the problems that present themselves. The preparation for special practice cannot be too broad as to principles, but, at the same time, there is a practical limit to the detail of general medicine that can profitably enter into the dental student's undergraduate work.

The matter entering into these chapters is written from a standpoint that recognizes the need of a special text-book, but that also realizes the narrowing tendency that inevitably attends the supplying of that need. The author, therefore, makes no apology for attempting to illustrate by diagrams, with explanatory text, the action of the most important internal drugs upon the general system, nor for the somewhat extensive treatment of classes of remedies and preparation of drugs.

Certain general terms require definition or comment at the outset.

The term **remedy** includes any agent, of whatever character, employed in the treatment of disease. A remedy is not necessarily a substance; it may be some external force or simply an influence.

A **medicine** is any substance administered or applied in the treatment of disease.

The term **drug** is inclusive, meaning any substance used in the composition of medicines or entering into chemical processes, or any poison.

Materia medica, in a restricted sense, means the materials or substances used in medicine. In a broad sense, the term means the science of drugs in their varied relations, *i. e.*, their sources, properties, preparations and uses.

Pharmacy is the science of preparing medicines for use. It includes not only the making of drug preparations, but also the art of compounding and dispensing medicines.

Pharmacology has had much the same meaning as materia medica in its broad sense, but it has more recently come to be applied to a distinct part of the science of drugs, that which treats of the action of drugs upon the tissues, organs and functions of the body.

Therapeutics is the science and art of employing remedies in the treatment of disease. While therapeutics should have a scientific basis in the knowledge of the action and effects of remedies, practical treatment of disease will always remain an art, because of the many modifying factors that render scientific precision impossible.

Toxicology is that part of medical science which treats of poisons. It includes the nature and effects of poisons, their doses, their detection, and the treatment of the conditions resulting from poisoning.

As a standard for the purity and uniformity of drugs and preparations, we have the volume known as the **United States Pharmacopœia,*** which is the recognized authority for this country. Other countries have similar standards. The book does not treat of the action or uses of medicines, but it furnishes a list of *recognized drugs,* with descriptions, tests of purity, etc., and of *preparations,* with their formulas. The drugs and preparations so recognized are called "official." An *average dose* is given of each drug and preparation used internally. This book,

* The U. S. Pharmacopœia was first issued in 1820. It is subjected to revision every ten years. It is not issued by the Government, as is the case with the pharmacopœias of most countries, but it is authorized by the professions of medicine and pharmacy. A convention, representing medical and pharmaceutical colleges and associations, meets once in ten years in the city of Washington, for the purpose of directing its revision, which is accomplished through a committee of revision.

being our authority upon drugs and their preparations, forms the basis of our text-books on materia medica, pharmacy and therapeutics. It is revised every ten years under direction of the professions of medicine and pharmacy. The abbreviation (U. S. P.) always indicates this work.

A **Dispensatory** is a comprehensive text-book on materia medica. It has been called a commentary upon the Pharmacopœia; but it is more than this, in that it treats of a vast number of substances that are not official, and discusses also the *uses* of drugs. But it is not an authorized work as is the Pharmacopœia.

The **National Formulary** (N. F.) is a very important collection of formulas that are not official, but which are in common use. It is prepared under the direction of the American Pharmaceutical Association, and is, therefore, in a sense authoritative.

In the study of the practical values and uses of remedies we employ several related terms which are too often confused. *Physiologic action, physiologic effect* and *therapeutic effect* are terms distinct in meaning, and they should be properly understood. The action and effect of a drug cannot always be the same. The action may be obscure; the effect must be apparent. To illustrate: Tincture of iodine applied in a case of pericementitis has its *action* upon the mucous membrane where applied, but the *physiologic effect* that we desire is alteration of the disturbed circulation in the pericementum. Again, we may have physiologic action and physiologic effect without therapeutic effect, the latter depending upon a relief of symptoms. In the above condition the *therapeutic effect* would be relief of the pain; but the inflammation might be so severe that our therapeutic effect would not follow.

The *action* of a drug, then, consists of a change of conditions, chemic, thermic, electric or structural, which determines an alteration of function. This alteration, when apparent, is known as the *effect* of the drug. Within the limits of normal function this effect is *physiologic,* while a disturbance, or depression beyond the normal, is a *toxic* effect. When the action is in the direction of restoring normal conditions, the effect is usually a relief of symptoms of disease, and is called the *therapeutic effect.* We may have the action and the physiologic effect of a drug in a normal, healthy individual, but never the therapeutic effect.

Some drugs may cause unpleasant or undesirable effects aside from their main action. These are called *untoward* effects, and their avoidance calls for discrimination in administration and dosage. Closely related is the matter of *susceptibility* to drug action, some individuals

being very sensitive to the influence of a certain drug and readily showing untoward effects of the same. On the other hand, *tolerance* to certain drugs may be acquired by continued use, so that very large quantities may be taken without dangerous results. The habit drugs, particularly morphine and cocaine, exhibit this fact; victims of habitual use of either often being able to take many times the poisonous dose.

A *cumulative* effect is sometimes seen with slowly acting drugs, particularly when elimination is faulty. The successive doses given accumulate and their full action is likely to be excessive, disturbing or poisonous. Digitalis is a drug which needs care in its use to avoid cumulative effect.

As related to the employment of remedies, the term *indication* means the symptom or condition that calls for a particular remedy or course of treatment, while *contra-indication* means the condition or symptom that forbids the use of a certain remedy or method. A *symptom* is an evident disturbance or alteration of function or structure, which is the expression of disease. A *sign* is a symptom or phenomenon that is positive evidence of some particular disease. *Diagnosis* means the determination, by means of symptoms or signs, of the character or name of the disease, while *prognosis* is the prediction of the course or termination of the same.

The term *resolution* indicates the changes in diseased tissues toward the normal, and means structural recovery. *Dissolution*, on the contrary, means death. The term *specific* has two meanings. Applied to a remedy, it means that the remedy can be invariably relied upon to produce a therapeutic effect in a certain disease, as quinine in malarial fever or antitoxin in diphtheria; but when we speak of *specific disease* we mean syphilis. The term is thus used among physicians to designate, in a way that cannot give offence, that disease that in its true name has the stigma of vice attached to it.

CHAPTER I.

DRUGS AND MEDICINES: THEIR CONSTITUENTS AND PREPARATIONS.

THE terms *drug* and *medicine* are not strictly synonymous, although popularly so regarded. Both mean material substances, therefore they exclude such agents as heat, light and electricity. The term *medicine* implies use in the treatment of disease, while the classes of *drugs* include many substances that are known usually as chemicals and that are never used directly in treatment. Therefore:

A **medicine** is any substance administered or applied in the treatment of disease.

A **drug** is any substance used in the composition of medicines or in chemical processes.

A *poisonous* drug is one which is capable of causing a disturbance of function, or disease, or death. **Poisons** must be included among drugs, but in their poisonous quantities they cannot be medicines, although a substance that in a large dose is a poison may in a smaller dose be a medicine. Poisons are discussed in greater detail in a separate chapter.

The term **remedy** is more inclusive than the term medicine, meaning any agent (whether a substance, a force, or any influence whatever) employed in the treatment of disease. In another chapter occurs the classification and discussion of remedies.

Drugs are classified variously: in respect of their sources, as *vegetable* drugs, *mineral* drugs and *animal* drugs; regarding their constitution, as *organic* and *inorganic;* and respecting their uses, as *medicinal* and *chemical* drugs.

In the development of the science of drugs, the beginning had to be with two quite distinct groups of substances—the *simple chemicals,* or chemical elements as we now know them, such as zinc, mercury and iron, and the more *complex organic vegetable drugs,* such as opium, cinnamon and ipecacuanha. The chemical elements, as a rule, were found to possess comparatively slight medicinal value while in their simple form, and except for their power of chemical combination would have remained of little use. Their great value, therefore, depends upon

the large number of useful combinations which they form. To illustrate: Mercury or quicksilver in its pure form is insoluble and non-medicinal, but combined with chlorine in a certain proportion it yields calomel ($HgCl$), a valuable cathartic; and in another proportion it yields corrosive sublimate ($HgCl_2$), a powerful antiseptic; again, it may be combined with sulphur to produce a valuable red coloring agent known as vermilion (HgS). An almost endless variety of combinations among the eighty-three chemical elements now known, provides a field from which we draw many agents used in dentistry, with a limitless future as to new compounds.

Much of both scientific and commercial energy is being expended in the synthesis, or putting together, of chemicals in order to secure new valuable compounds. The products are often referred to as **synthetics.** Phenacetin and saccharin are examples of this class. Remarkable also it is, that, besides new products, many of the active principles originally obtained from organic drugs are now produced synthetically in the laboratory. Salicylic acid, artificial oil of wintergreen, and even phenol, furnish examples of such.

In strong contrast to the above, the other group, the *organic drugs,* besides being of use in their crude form, lend themselves to division and analysis rather than to combination. They are complex in their composition, therefore one organic drug may contain from one to a dozen or more distinct substances of medicinal value. These are called *constituents, active principles* or *proximate principles* of the drug. For example, opium, the juice of the unripe seed-capsule of the opium poppy, contains gum, albumin, sugar, wax, pectin, salts, caoutchouc, acids and at least twenty alkaloids, among which are morphine and codeine. The most important work being now done upon these complex drugs is that of isolating their active principles or constituents in a state of purity and stability; and when a single principle is found to represent the drug fully it is commonly used in its stead.

We have, therefore, in the rational grouping of drugs:

1. The *chemical* substances and their elaborated compounds.

2. The *organic* crude substances (of vegetable and animal origin) and their isolated active principles.

PREPARATIONS OF DRUGS.

Nearly all of the organic and many chemical drugs are not in proper form for administration without further preparation, hence the elabo-

ration of our materia medica to include a large number of preparations which represent more or less completely, in medicinal value, the simple or crude substances.

It would be interesting to trace the development of pharmacy in bringing forth the different kinds of preparations, in response always to definite needs, and to note individual characteristics in each class; but it must suffice to state in general that they fulfil needs in preparation, such as solubility and permanency, and likewise needs in administration, such as pleasant form and taste, definiteness of strength, external uses, etc.

These preparations are obtained by simple solution of a drug, by extraction of its active principles, or by incorporation of it with a vehicle, the objects of such preparations being to secure the medicine in a suitable form, in definite strength, and in a permanent or stable condition. Occasionally chemical action is employed, but the larger number are produced without any chemical change occurring in the ingredients. The preparations produced without chemical action are known as **galenical** preparations, being so named after the ancient physician Galen.

With so many drugs, furnishing so large a number of preparations, the need of standards of identity, purity, strength, etc., is very apparent. Such standards are provided in the *United States Pharmacopœia*.*

As regards strength of organic drugs the amount of active principle present seemed to be the best basis for standardization, and much progress has been made in recent years in establishing processes of assay to which the substances must conform. Several that do not admit of a determinative chemical assay are now tested biologically. Tests of various salts and chemicals have been also added, so that now the *Pharmacopœia* gives about 300 assays of drugs and preparations. This contributes very much to definiteness and insures greater reliability and accuracy in the use of our most important medicines.

Among all of the classes, the *fluidextracts* deserve emphasis as the most representative preparations of the crude organic drugs. They are so prepared as to contain all of the active principles, to be of a uniform definite strength, and to keep indefinitely. The *tinctures* may be regarded as equal in importance, being permanent alcoholic solutions of drugs, though weaker than fluidextracts. *Syrups* present the drugs in form for pleasant administration, as also do *pills* and *troches*.

* See page 18 and footnote.

Plasters, liniments and *ointments* illustrate the adaptation of drugs to external uses.

The various preparations are presented in the following list, arranged in classes alphabetically, with each class defined, and the names given of the most important ones, or those of interest to the dental specialist. The names given, both for each class and each individual preparation, are those employed in the official volume, the *U. S. Pharmacopœia.*

CLASSES OF OFFICIAL PREPARATIONS.

Acetum.—A Vinegar.—A solution of a medicinal substance in diluted acetic acid. Vinegars have an acid reaction.

Acetum scillæ.

Aqua.—A Medicated Water.—A solution of a volatile substance in water.

*Aqua ammoniæ (10 per cent.).
*Aqua ammoniæ fortior (28 per cent.).
*Aqua amygdalæ amaræ.
Aqua anisi.
Aqua aurantii florum.
Aqua camphoræ.
*Aqua chloroformi (about 0.5 per cent.)
Aqua cinnamomi.
Aqua creosoti.
Aqua menthæ piperitæ.
Aqua rosæ.

Those marked thus (*) may be either irritating or poisonous when used freely. All others are harmless, being used mostly as flavoring agents.

Ceratum.—A Cerate.—A preparation having a fatty base with a melting point above the temperature of the body.

Ceratum.
Ceratum cantharidis (35 per cent.).

Cerates are used only for local medication or protection.

Collodium.—A Collodion.—A liquid preparation for external use, having as a basis a solution of guncotton in a mixture of ether and alcohol.

Collodium.
Collodium cantharidatum.
Collodium flexile.

Collodia are employed to protect or to constrict tissue, or to apply an irritant drug to the skin. Having the nature of a varnish, they cannot be applied unless the surface is perfectly dry. They dry quickly by evaporation of the ether and alcohol.

Decoctum.—A Decoction.—A liquid preparation made by boiling a vegetable drug in water. Not used where active principle is volatile.

The U. S. Pharmacopœia gives a general formula for decoctions of 5 per cent. strength. Unless some preservative is added, they do not keep well; so they must be freshly prepared.

Elixir.—AN ELIXIR.—A sweetened, aromatic, spirituous preparation of one or more drugs, designed for pleasant administration.

Elixir aromaticum.	Elixir glycyrrhizæ.

Some elixirs are used only as vehicles, their alcoholic character permitting the addition of fluidextracts without precipitation. The National Formulary contains the formulas of a large number of elixirs for the administration of drugs of unpleasant taste.

Emplastrum.—A PLASTER.—A solid preparation for external use, adhesive at the temperature of the body.

Emplastrum belladonnæ.	Emplastrum elasticum.
Emplastrum capsici.	*Emplastrum ichthyocollæ.
Emplastrum cantharidis.	Emplastrum sinapis.

These are usually spread upon muslin and are intended for protection to the skin, or for the application of either irritating or sedative drugs.

Emulsum.—AN EMULSION.—A liquid preparation. in which oil or resinous matter is held in suspension in water. They require a viscid or mucilaginous substance in order to effect and maintain the suspension of the insoluble particles.

Emulsum amygdalæ.	Emulsum olei morrhuæ (cod-liver oil).
Emulsum asafœtidæ (4 per cent.).	Emulsum olei terebinthinæ.

Emulsions are in no sense solutions, their object being to carry substances that are not soluble in water. In case of asafœtida, a gum-resin, there is sufficient gum in the drug to carry the resin, so that the emulsion is formed by rubbing up the drug with water only.

Extractum.—AN EXTRACT.—A solid or semisolid concentrated preparation of the soluble constituents of a drug.

Extractum aconiti.	Extractum glycyrrhizæ.
Extractum belladonnæ foliorum.	Extractum malti.
Extractum colocynthidis.	Extractum nucis vomicæ.
Extractum ergotæ.	Extractum opii.

The object of this class is chiefly concentration of the drug, but the keeping qualities are usually also improved. The form permits of their being made readily into pills, or of ready solution.

Fluidextractum.—A FLUIDEXTRACT.—An alcoholic or hydro-alcoholic solution, one milliliter† of which represents one gram of the crude

* Courtplaster, an exception to the rule, is applied with moisture. (Not official.)
† Formerly called cubic centimeter.

drug. [Acids or alkalies are sometimes used to aid in the extraction of the principles.]

Fluidextractum aconiti.
Fluidextractum aurantii amari.
Fluidextractum belladonnæ radicis.
Fluidextractum digitalis.
Fluidextractum ergotæ.
Fluidextractum glycyrrhizæ.
Fluidextractum guaranæ.
Fluidextractum hydrastis.
Fluidextractum ipecacuanhæ.
Fluidextractum nucis vomicæ.

Fluidextracts constitute the most representative class of preparations, there being 49 official. Their drug strength is uniformly 100 per cent.

Glyceritum.—A GLYCERITE.—A solution of a medicinal substance in glycerin.

Glyceritum acidi tannici (20 per cent.).
Glyceritum boroglycerini (31 per cent. of boric acid).
Glyceritum hydrastis (100 per cent.).
*Glyceritum phenolis (20 per cent.).

Infusum.—AN INFUSION.—A liquid preparation made by macerating a vegetable drug in hot or cold water.

Infusum digitalis.
Infusum sennæ compositum.

There is also a general formula for infusions of 5 per cent. strength. These preparations do not keep well. Either they must be freshly made or some preservative added.

Linimentum.—A LINIMENT.—A liquid preparation for external use, usually possessing a stimulating or sedative property. Liniments vary much in character, but most of them contain some oil or soap.

Linimentum ammoniæ.
Linimentum belladonnæ.
Linimentum calcis. *Carron oil.*
Linimentum camphoræ. *Camphorated oil.*
Linimentum chloroformi (30 per cent.).
Linimentum saponis.
Linimentum saponis mollis.
†Linimentum terebinthinæ (35 per cent.).

Liquor.—A SOLUTION.—An aqueous solution of one or more non-volatile substances. [In some a chemical reaction is employed to obtain the desired product.]

Liquor arseni et hydrargyri iodidi.
Liquor arseni arsenosi (1 per cent.).
Liquor calcis. *Lime-water.*
Liquor cresolis compositus.
Liquor ferri chloridi.
Liquor ferri subsulphatis. *Monsel's solution.*
Liquor ferri tersulphatis.
Liquor formaldehydi.
Liquor hydrogenii dioxidi (3 per cent.).
Liquor iodi compositus (5 per cent. iodine). *Lugol's solution.*
Liquor plumbi subacetatis.
Liquor potassii arsenitis.
Liq. potassii hydroxidi (4.5 per cent.).
Liquor sodæ chlorinatæ (2.5 per cent. chlorine).
Liquor sodii arsenatis.
Liquor sodii hydroxidi (4.5 per cent.).
Liquor zinci chloridi (50 per cent.).

* Formerly glyceritum acidi carbolici.

† Linimentum terebinthinæ (turpentine liniment) may be semisolid.

Massa.—A MASS.—A mixture of substances of the proper consistence to be made into pills.

Massa ferri carbonatis.

Massa hydrargyri. *Blue pill* (33 per cent. mercury).

Mistura.—A MIXTURE.—An aqueous liquid preparation usually holding some insoluble matter in suspension.

Mistura cretæ.

Mistura glycyrrhizæ comp. *Brown mixture.*

Mucilago.—A MUCILAGE.—A solution of a gum or vegetable mucilage in water. Mucilages are used as demulcents, or as excipients in various preparations.

Mucilago acaciæ (35 per cent.).

Mucilago tragacanthæ.

Oleatum.—AN OLEATE.—A solution of a medicinal substance in oleic acid. Oleic acid here contributes a superior penetrating quality.

*Oleatum cocainæ (5 per cent.).

Oleatum hydrargyri (25 per cent. yellow oxide).

*Oleatum veratrinæ (2 per cent.).

Oleoresina.—AN OLEORESIN.—A liquid or semiliquid mixture, chiefly of oil and resin, extracted from the drug by percolation with ether. [They are really ethereal extracts.]

Oleoresina aspidii.

Oleoresina capsici.

Oleoresina cubebæ.

Oleoresina zingiberis.

The term also applies to certain natural products, consisting of mixtures of oil and resin, which occur as exudates from the trees containing them. These may be liquid or solid. Examples are:

Copaiba (liquid).

* Terebinthina (solid).

Oleum.—AN OIL.—A natural compound of one or more of the fatty acids with glycerin. True oils and fats must be capable of saponification, *i. e.,* forming a soap when treated with an alkali. They vary in consistence and in melting point, chiefly on account of the varying proportions of olein, palmitin and stearin which they contain. They are not volatile. They occur naturally in animal tissues and in the seeds of many plants and trees.

Oleum amygdalæ expressum.

Oleum gossypii seminis.

Oleum lini (*linseed oil*).

Oleum morrhuæ (*cod-liver oil*).

Oleum olivæ (*olive oil*).

Oleum ricini (*castor oil*).

Oleum tiglii (*croton oil*).

* Not official.

The solid fats are:

Adeps (*lard*).
Adeps lanæ (*lanolin*).
Oleum theobromatis (*cacao butter*).
Sevum præparatum (*suet*).

Spermaceti and wax are similar to these in that they are saponifiable, but they contain no glycerin. Petrolatum (vaselin) is not a fat, although it may be used as a basis in ointments.

Oleum Destillatum.—A Distilled Oil. [Volatile Oil. Essential Oil.]—A volatile, oily principle usually obtained from the crude drug by distillation. They are not saponifiable, therefore they are not true oils. The volatile oils are usually the essential principles of the plants yielding them. It will be noticed that many of them are obtained from spices.

*Oleum amygdalæ amaræ (*bitter almond*).
Oleum aurantii (*orange*).
Oleum cajuputi.
Oleum caryophylli (*cloves*).
Oleum cassiæ (*oil of cinnamon*).
Oleum eucalypti (contains eucalyptol).
Oleum gaultheriæ (*methyl salicylate; oil of wintergreen*).
Oleum limonis (*lemon*).
Oleum menthæ piperitæ (*peppermint*).
*Oleum sinapis volatile (*mustard*).
Oleum terebinthinæ (*turpentine*).
Oleum thymi.

Pilula.—A Pill.—A spherical or oval mass, containing one or more medicinal ingredients, intended to be swallowed whole.

Pilulæ (*plur.*) aloes (gr. 2 in each).
Pilulæ asafœtidæ (gr. 3 in each).
Pilulæ catharticæ compositæ (gr. 1 of calomel included in each pill).
Pilulæ ferri carbonatis.
Pilulæ ferri iodidi.
Pilulæ phosphori (gr. $\frac{1}{100}$ in each).
Pilulæ rhei compositæ.

The chief object in the use of pills is to avoid the unpleasant taste of medicines. Sometimes, however, they may be used in order to secure a slow or delayed absorption of the medicine.

Resina.—A Resin.—A solid preparation consisting chiefly of resinous substances. They are insoluble in water, and are usually obtained by precipitation from tinctures by the addition of water. As a class resins are soluble in alcohol, ether, chloroform and oils. They soften with the aid of heat.

Resina (*rosin*).
Resina jalapæ.
Resina podophylli.
Resina scammoniæ.

* These do not exist ready formed in the drug, but are developed when the drug is moistened with water, in the presence of which a reaction between certain constituents occurs, with the formation of the volatile oil. This process must precede distillation in case of these. With the exception of these two, which are poisonous and should never be given in larger dose than ♏$\frac{1}{2}$ (0.03 gm.), the dose of the volatile oils is ♏1–5 (0.06–0.30 gm.).

Gum-resins are related to the above, but differ from them in composition and solubility. They contain a gum associated with the resin; therefore they are only partly soluble in alcohol and are partly soluble also in water. The two most important ones are:

Asafœtida.	Myrrh.

Balsamic Resins and Balsams also belong to the group of resinous substances. They are characterized by the presence of benzoic or cinnamic acid. They include:

Benzoinum.	Balsamum peruvianum.
Styrax.	Balsamum tolutanum.

Sapo.—A Soap.—An alkaline product of the reaction between a fatty acid and either soda or potassa.* Soaps are prepared by heating a fat or oil with an alkali—potassa yielding a soft soap and soda a hard soap.

Sapo (*white castile soap*).	Sapo mollis (*soft soap*).

Spiritus.—A Spirit.—An alcoholic solution of a volatile substance. Many of the spirits are prepared from the volatile oils.

Spiritus ætheris (32.5 per cent.).
Spiritus ætheris nitrosi.
Spiritus ammoniæ aromaticus.
Spiritus anisi (10 per cent. oil).
Spiritus camphoræ (10 per cent.).
Spiritus chloroformi (6 per cent.).
Spiritus cinnamomi (10 per cent. oil).
Spiritus glycerylis nitratis (1 per cent. nitroglycerin).
Spiritus lavandulæ (5 per cent. oil).
Spiritus menthæ piperitæ (10 per cent. oil).
Spiritus myrciæ (*bay rum*—not official).

Suppositorium.—A Suppository.—A solid, conical mass, containing one or more medicinal substances, intended for introduction into some passage or cavity of the body. A suppository should melt readily at the temperature of the body, to ensure which a base of either cacao butter or glycerinated gelatin is commonly employed. The size may vary from 15 to 60 grains (grams 1 to 4). The U. S. P. gives general directions for their preparation with either base.

They are made of different shapes, according to the particular use for which they are intended. Those for introduction into the urethra, often called *bougies*, are pencil shaped, while for rectal and vaginal use they are conical or oval.

The following is exceptional in being prepared with sodium stearate as a base, and in being used simply as laxative, acting by local irritation.

Suppositoria (*plur.*) glycerini. (These contain about 80 per cent. of glycerin with a soap for a base.)

* This definition is a restricted one, intended to define the official soaps. Chemically speaking, the salt of a fat acid with any inorganic base is a soap.

Syrupus.—A Syrup.—An aqueous medicinal solution containing sugar nearly to saturation. [A few syrups are without decided medicinal value, being used chiefly as vehicles.]

Being rather thick in consistence, they may hold solid particles in suspension, thus possessing added value as excipients, and their consistence also gives them something of the quality of demulcents. As a rule, they are weaker than tinctures.

Two objects are secured in this class of preparations—preservation and pleasant taste—both of which are due to the large amount of sugar present.

Syrupus (85 per cent. sugar).
Syrupus acaciæ.
Syrupus acidi citrici.
Syrupus aurantii.
Syrupus ferri iodidi.
Syrupus hypophosphitum.
Syrupus ipecacuanhæ.
Syrupus lactucarii.
Syrupus pruni virginianæ.
Syrupus rhei.
Syrupus rhei aromaticus.
Syrupus scillæ.
Syrupus scillæ compositus.
Syrupus tolutanus.
Syrupus zingiberis.

Tinctura.—A Tincture.—An alcoholic or hydroalcoholic solution of the active principles of a crude drug or of a non-volatile substance. Tinctures are weaker than fluidextracts and have no uniform strength as a class, except that tinctures of potent drugs are of 10 per cent. strength.

Tinctura aconiti.
Tinctura belladonnæ foliorum.
Tinctura benzoini.
Tinctura benzoini composita.
Tinctura cantharidis.
Tinctura capsici.
Tinctura cinchonæ.
Tinctura cinchonæ composita.
Tinctura cinnamomi.
Tinctura digitalis.
Tinctura ferri chloridi.
Tinctura gambir composita.
Tinctura gentianæ composita.
*Tinctura iodi (7 per cent.).
Tinctura kino.
Tinctura lavandulæ composita.
Tinctura myrrhæ.
Tinctura nucis vomicæ.
Tinctura opii (10 per cent.).
*Tinctura opii camphorata (0.4 per cent. opium).
Tinctura opii deodorati (10 per cent.).
Tinctura tolutana.
Tinctura veratri.
Tinctura zingiberis.

In point of number the tinctures hold first place, there being 54 official.

Trituratio.—A Trituration.—A powder consisting of a potent drug diluted and finely divided by means of sugar of milk. The U. S. P. gives a general formula for the preparation of 10 per cent. triturations. The following is the only official one named separately:

Trituratio elaterini.

(See Tablet Triturates following.)

* In these some of the medicinal constituents are quite volatile.

Trochiscus.—Tabella.—A TROCHE OR TABLET.—A solid preparation in tablet form, consisting of one or more medicinal substances combined with sugar and mucilage.

Trochisci (*plur.*) acidi tannici (gr. 1 in each).
Trochisci ammonii chloridi (gr. 1½ in each).
Trochisci cubebæ (♏ ⅓ of oleoresin in each).
Trochisci sodii bicarbonatis (nearly gr. 3 in each).
Toxitabellæ hydrargyri chloridi corrosivi (gr. 7½ in each).

Several subdivisions of the class of troches must now be recognized, some of which do not conform exactly to the definition given above.

TABLET TRITURATES combine the characters of the trituration and the troche, having the medicine in a finely divided state and in a form pleasant to take. A great variety of combinations are now prepared in this form, presenting a convenience of handling and of administration that does not obtain with the liquid forms of medicine. With some drugs, however, the fresh liquid preparations are more reliable and greatly to be preferred.

HYPODERMIC TABLETS.—For hypodermic use it is desirable to have the medicine readily soluble, therefore the tablet should contain little or nothing besides the active substance. With some drugs a little mucilage may be required to secure adhesion of the particles, but the least possible amount should be used.

COMPRESSED TABLETS.—Many substances are sufficiently cohesive to admit of being compressed into tablet form without the addition of any adhesive material. Some that take the tablet form readily do not maintain it indefinitely. They may be deliquescent and become soft or even liquid; or they may be efflorescent and become dry and crumble. Such will require to be kept in tightly-corked bottles. The compressed tablets, however, are very convenient and usually present the drug in its pure form.

Unguentum.—AN OINTMENT.—A semisolid fatty preparation for external use, having a melting-point near the temperature of the body.

Unguentum acidi borici (10 per cent.).
Unguentum acidi tannici (20 per cent.).
Unguentum aquæ rosæ.
Unguentum belladonnæ (10 per cent. extract).
Unguentum gallæ (20 per cent.).
Unguentum hydrargyri (50 per cent.).
Unguentum hydrargyri ammoniati (10 per cent.).
Unguentum hydrargyri dilutum (30 per cent.).
Unguentum iodi (4 per cent.).
Unguentum phenolis (2¼ per cent. of liquefied phenol).
Unguentum sulphuris (15 per cent.).
Unguentum zinci oxidi (20 per cent.).

Ointments are intended to protect, soften or medicate the skin. A few, such as unguentum hydrargyri, are used for the purpose of systemic medication by being rubbed into the skin.

CONSTITUENTS OF DRUGS.

In the foregoing list of preparations there are some that are, as well, simple constituents. This is true of the oils, the distilled oils and the resins, these being obtainable by simple means in a fairly pure state. but there are other constituents that are less easily separated from the drug, but which are usually the most active and important of its principles.

As we study the value of an organic drug in its desirable medicinal effects, it is evident that the latter must be dependent, not upon the whole drug, but upon the action of one or more of its constituents or proximate principles;* for every crude drug contains inert matter, while some have constituents of undesirable action. It is important to know just which of the principles are medicinally valuable; and where such are capable of isolation there is evident advantage in their employment instead of the preparations of the whole drug.

Their recognition depends upon their possessing a definite chemical character which is not essentially altered in the process of extraction.*

Since the recognition of morphine in opium by Setürner, in 1817, much effort has been expended in securing the active principles of the various drugs in a state of purity and solubility for practical use. So successful has the effort been with many of our leading drugs that their quality is now gaged by the amount of active principles present, *e. g.*, opium cannot be official unless it contains 9.5 per cent. of morphine.

Of all classes of active constituents the alkaloids and the glucosides are most important and distinct.

Alkaloids.—These are defined to be nitrogenous compounds of organic origin, having the reaction and basic property of alkalies. The following are some of the most prominent alkaloids:

Aconitine, from aconite.
Atropine, from belladonna.
Caffeine, from tea, coffee and guarana.
Cinchonine, from cinchona.
Cocaine, from coca leaves.
Codeine, from opium.
Emetine, from ipecacuanha.
Hydrastine, from hydrastis.
Hyoscyamine, from hyoscyamus.
Morphine, from opium.
Narcotine, from opium.
Nicotine, from tobacco.
Pilocarpine, from pilocarpus.
Quinine, from cinchona.
Scopolamine or hyoscine, chiefly from hyoscyamus and stramonium.
Strychnine, from nux vomicæ.
Veratrine, from asagræa officinalis.

* The term *proximate principle* is defined to be any substance, either simple or compound, which is present in its own form in the drug, as proven by its being capable of extraction without change of its chemical properties.

Alkaloids have a definite chemical composition. Most of them are crystallizable, although a few are liquid, *e. g.*, nicotine. Most of them are bitter to the taste, some intensely so.

The pure alkaloids, as a rule, are nearly insoluble in water, but their basic character permits the formation of salts that are freely soluble. For example, while cocaine requires 600 parts of water to dissolve it, cocaine hydrochloride is soluble in 0.4 part of water, or 1500 times more soluble than simple cocaine. Therefore, almost without exception, soluble salts of alkaloids are used instead of the simple substances. Double salts also are sometimes employed.

Alkaloids usually represent much or all of the activity of the drugs containing them, and it is believed that they exist in the drugs only in combination with acids. This has been proven to be true of many of them, *e. g.*, morphine exists in opium in combination with either sulphuric or meconic acid, *i. e.*, as sulphate or as meconate of morphine; strychnine is combined in nux vomica with igasuric or "strychnic" acid, etc.

As a class, we accord alkaloids the preëminence among medicines. Their action is chiefly upon the nervous system, through which they may exert an indirect influence upon other kinds of tissue. They have almost no influence upon elimination, none of them being classed among the cathartics. They are very active agents in comparatively small medicinal doses, and many of them are poisonous to the nervous system when given in large doses. Because of smallness of dose, ready solubility, and the fact that they are not irritating to tissues, as a rule, most of their salts may be used hypodermically. They furnish our most powerful narcotics and anodynes. Two especially, morphine and cocaine, present the danger of drug habit through unguarded or continued use.

In some drugs these principles are very numerous. Opium and cinchona, for instance, each yield twenty or more alkaloids.

Artificial Alkaloids.—Besides the large number of alkaloids existing naturally, a number of others have been produced artificially, usually by subjecting a natural one to chemical change. Some of these artificial bodies are valuable additions to the list, as they are found in some instances to have an action quite distinct from that of the original alkaloid.

The principal artificial alkaloids are:

Apomorphine, from morphine.
Betaeucaine (eucaine), from piperidine.
Cotarnine (stypticin), from narcotine.
Diacetylmorphine (heroine), from morphine.
Ethylmorphine (dionin), from morphine.
Homatropine, similar to atropine.
Hydrastinine, from hydrastine.
Novocaine, a synthetic product.

Incompatibility of Alkaloids.—Drugs are said to be incompatible with each other when their mixture results in an undesired physical or chemical change. In using either natural or artificial alkaloids we must have in mind their incompatibility with certain other substances, as given below:

1. *With Alkalies.*—The basic power of the alkaloids is exceeded by that of the ordinary alkalies, therefore the latter easily decompose the salts of the former. Hence, it may be stated that *alkaloidal salts in solution are incompatible with alkalies and alkaline carbonates,* the mixture leading to precipitation of the alkaloid. The danger here is from the deposited drug, which might be taken in poisonous quantity in the last one or two doses of the mixture.

2. *With Tannic Acid.*—Alkaloids unite with tannic acid to form tannates, which are insoluble; therefore, *alkaloids and their salts in solution are incompatible with tannic acid* or with any preparation containing it, the mixture resulting in a deposit of the tannate of the alkaloid.*

3. *With Metallic Salts.*—Certain metallic salts, especially double salts or double iodides, cause precipitation when mixed with alkaloidal solutions. Lugol's solution also will precipitate the salts from solution.

Ptomaines and Leukomaines.—Two other classes of bodies belonging to the group of organic bases, but which are in no sense medicines, should be mentioned here because of their similarity to the vegetable alkaloids. They are *ptomaines,* or putrefactive alkaloids, which are basic substances produced by the action of bacteria upon organic matter, and *leukomaines,* which are basic substances resulting from normal tissue metabolism. The former are of special interest as contributing to the toxicity of many bacterial diseases, and from the resemblance of certain of them in their action to the vegetable alkaloids. Thus, tetanine, present in the disease tetanus, or lockjaw, produces the characteristic spasms of this disease, which resemble closely those produced by strychnine. Others are narcotic in action, bearing some resemblance to morphine or atropine.

Glucoides.—This class comprises those vegetable proximate principles which, when decomposed by boiling with acids or alkalies, or by

*There seems to be a contradiction to the above in the fact that a number of vegetable drugs contain both tannic acid and alkaloids, without any precipitation occurring in their liquid preparations. The explanation of this is that the alkaloid is present in a natural combination, which is not broken up by the peculiar tannic acid that is its natural associate in the particular drug; or the alkaloid may be in natural combination with the tannic acid.

the action of ferments, yield glucose, with some other product peculiar to the substance tested. Some have the chemical behavior of acids, while some resemble resins in nature.

Neutral principles are somewhat similar, but have neither alkaline nor acid properties.

These two classes form a group, some members of which are of great value in medicine. Santonin, aloin, glycyrrhizin, amygdalin, digitalin, and elaterin furnish examples. While their uses are varied, the activity of many of them is addressed to the eliminative functions. Especially do we find them in the cathartic drugs. As a class they influence the nervous system less than do the alkaloids, and they are less poisonous.

CHAPTER II.

REMEDIES: THEIR CLASSIFICATION AND DEFINITIONS.

THE term **remedy** includes any agent, of whatever character, employed in the treatment of disease. It may be a medicine or an external force or influence. It may be intended for internal administration, for external application, or for less direct mental influence. Remedies are usually grouped as follows:

Preventive remedies, those that are employed to prevent the acquisition, development, or propagation of disease, *e. g.*, vaccination to prevent smallpox, and disinfection to prevent the spread of any infectious disease.

Since it has become known that all infectious diseases are preventable, this group has attained a rank of first importance.

Hygienic remedies, those that conduce to the maintenance of health and of good resistive power against the causes of disease. They include proper food, ventilation, exercise, bathing, etc.

This group is closely related to the preceding and, on the whole, stands next to it in importance, it being a sound principle that such natural means of preventing or correcting diseased conditions, when efficient, should be held as preferable to artificial medicinal or mechanical means.

Mechanical remedies, those that involve the application of mechanical principles or appliances, *e. g.*, restraint, the use of splints, bandages and surgical instruments.

Imponderable remedies include forces or influences that are not material in nature, *e. g.*, heat, electricity, sunlight.

Medicinal or **pharmacologic remedies,** the substances administered or applied in the treatment of disease. They are known as **medicines.** They are intended to directly modify functions, or to antagonize the process of disease, or remove its results. Being material in nature, they form the basis of pharmacology, or the study of the action of medicines.

Our classification will concern this group chiefly, and will be based upon action and uses, rather than the sources of the various substances.

Classification of Remedies.

- REMEDIES
  - Local.
  - General.

- Local Remedies
  - Depletives.
  - Rubefacients.
  - Vesicants.
  - Escharotics.
  - Demulcents.
  - Emollients.
  - Astringents.
  - Hemostatics.
  - Detergents.
  - Antacids (alkalies).
  - Antiseptics.
  - Bleaching agents.
  - Analgesics.

- General Remedies
  - Stimulants (tonics)
    - Arterial stimulants
      - Diffusible.
      - Cardiac.
      - Vascular.
    - Nerve stimulants
      - Cerebral.
      - Spinal.
      - Vasomotor.
    - Digestive stimulants.
  - Alteratives.
  - Sedatives
    - Arterial sedatives
      - Cardiac.
      - Vascular.
    - Nerve sedatives
      - Anodynes.
      - Hypnotics.
      - Narcotics.
      - Anesthetics.
      - Antipyretics.
  - Antispasmodics.
  - Eliminatives
    - Errhines.
    - Sialagogues.
    - Emetics.
    - Expectorants.
    - Diaphoretics.
    - Diuretics.
    - Cathartics.
  - Antiseptics.
  - Antitoxins.
  - Vaccines.
  - Digestants.
  - Anthelmintics.

DEFINITIONS.

Local Remedies.

Depletive.—The class of local depletives includes the various means employed to abstract blood or serum from an inflamed or hyperemic area.

Scarification, leeching and cupping are the common means.

Rubefacient.—An agent that produces redness of the skin.

Vesicant or Epispastic.—An agent that produces a blister.

Escharotic or Caustic.—An agent that destroys tissue.

The terms rubefacient, vesicant and escharotic may represent the different degrees of action of the same agent in some instances.

Demulcent.—An agent that protects or soothes a raw, irritated or inflamed surface. It is usually an oily, mucilaginous or albuminous substance that directly coats over the surface, but it may be an agent that, upon a mucous surface, stimulates the natural secretion, which itself acts as a demulcent.

Emollient.—An agent that softens and soothes an inflamed part.

Poultices and ointments are the typical emollients.

Astringent.—An agent that causes contraction of tissue.

Hemostatic.—An agent employed to arrest hemorrhage. Besides the astringents, thermal and mechanical agencies are included.

Detergent.—An agent used to cleanse surfaces, wounds and ulcers.

Antacid.—An agent capable of neutralizing acids, by reason of either its alkaline or basic property.

Antiseptic (Local).—An agent that prevents the growth and propagation of septic bacteria.

Antiseptics, germicides and disinfectants form a related group which will be differentiated in connection with their detailed discussion.

Bleaching agents include the agents and means employed to remove discoloration of tooth structures.

Analgesic.—An agent that destroys sensibility to pain.

General Remedies.

Stimulant.—An agent that increases the activity of an organic function or process.

The action of stimulants is temporary and tends to exhaustion of reserve energy.

Tonic.—An agent that restores one or more lacking elements to the tissues, or promotes their nutrition, or conserves their reserve energy.

Alterative.—An agent that counteracts a morbid state of tissue by altering in a favorable manner the processes of nutrition. The action is usually obscure.

Alteratives become intimately associated with the tissue elements during their stay in the system; they act slowly and influence the vital processes.

Sedative.—An agent that diminishes the activity of an organic function or process.

Anodyne.—An agent that relieves pain.

An anodyne may depress sensory nerve endings, or lessen conductivity of nerve fibers, or diminish the receptivity of brain centers.

Hypnotic.—An agent that induces sleep.

Narcotic.—An agent that produces stupor.

The same agent may be anodyne or hypnotic in moderate dose and narcotic in large dose.

Anesthetic.—An agent that abolishes all sensation.

Antipyretic.—An agent that causes reduction of temperature in fever.

Antispasmodic.—An agent that relieves spasm or convulsion.

The term simply describes one effect of medicines that may be stimulating or sedative in their general action.

Errhine or Sternutatory.—An agent that increases the secretion of the nasal mucous membrane. The latter term refers especially to agents that cause *sneezing.*

Sialagogue or Ptyalagogue.—An agent that increases the secretion of saliva.

Emetic.—An agent that causes evacuation of the stomach.

Expectorant.—An agent that increases the secretion of the air passages.

Diaphoretic or Sudorific.—An agent that induces sweating.

Diuretic.—An agent that increases the excretion of urine.

Diuretics may act through the circulation by increasing arterial pressure or modifying the composition of the blood, or by directly stimulating the activity of the kidneys.

Cathartic.—An agent that causes evacuation of the intestinal tract.

Antiseptic (General).—An agent that, being absorbed, renders fluids or tissues of the body destructive of, or resistant to the growth of, bacteria or other parasitic bodies.

Antitoxin.—A serum that possesses the power to neutralize the toxic product of the bacteria of some particular disease.

Vaccine.—A substance used by inoculation or injection for the purpose of securing immunity to some disease.

Digestant.—An agent that aids the solution and preparation of foods for absorption.

Anthelmintic.—An agent that destroys intestinal parasites.

The same agent may be a *vermifuge,* the latter term referring to expulsion of the parasites.

CHAPTER III.

ADMINISTRATION OF MEDICINES.

It is a sound principle in medicine that the more nearly a remedial substance can be applied to the point of disease, the more effectual and the safer is its use. In accordance with this, our remedies should be applied locally as far as possible. The site of the disease, therefore, will determine in very many cases the selection of the site, avenue or method of application of a medicine. The urgency of a condition also will demand a choice of method, as an emergency often calls for the most rapid administration that is possible. We recognize various avenues and methods by which medicines are introduced to the system, and these require separate discussion.

By the Stomach.—Stomach or mouth administration is the original and common method employed for the great majority of medicines. As the stomach and intestine constitute the natural avenue of absorption of food substances, it is the one that most easily provides for solution and absorption of a medicine, and the one that is most tolerant of the introduction of an unusual substance.

It should be noted that absorption is more active from the small intestine than from the stomach; also that fluids begin to pass from the stomach into the intestine very soon after being swallowed.

A very soluble drug that requires only a small dose may be placed under the tongue, and absorption follows quickly. Nitroglycerin given in this way will produce its general effect within three minutes. It is, however, a very diffusible drug.

Form of Medicine.—The substance employed should be in a soluble condition, or in solution, if intended for absorption into the blood. For local effect in the stomach insoluble medicines are frequently used, *e. g.*, bismuth subnitrate.

The reaction of the gastric juice is acid; that of the intestinal juices is alkaline; thus, the solution of any substance soluble in either an acid or alkaline fluid is aided. We find that practically any substance that is even slightly soluble, whatever its form when swallowed, will in time find its way into the fluids of the body. Solution and absorp-

tion are sometimes aided by chemical change, as in the case of iron, which is changed to chloride of iron by union with the hydrochloric acid of the gastric juice. Some substances that require an alkaline liquid to dissolve them may pass through the stomach unchanged. This is true of salol, which is insoluble either in water or in an acid liquid. It reaches the small intestine unchanged, where it is soon decomposed and absorbed.

Rapidity of effect depends upon *solubility* and *rate of absorption.* Quinine sulphate given in powder form will require considerable time for solution, on account of its slight solubility except in the presence of a free acid. It will probably require the secretion of considerable gastric juice to dissolve a full dose of this drug; therefore, when given in powder, an hour or two will elapse before the effect is appreciated. The same drug given in solution will produce its effect much sooner, particularly if it be given when the stomach is empty. The rate of absorption depends somewhat upon the diffusibility of the medicine used, but all of the conditions that modify osmosis have their influence; the activity of the circulation, the state of blood-pressure, difference in specific gravity or degree of salinity between the stomach contents and the blood, and the physical character of the substance to be absorbed, must all have their influence. Fats and oils before they can be absorbed require to be saponified, which change occurs after they pass into the duodenum. Therefore, they are not absorbed at all from the stomach.

Among all of the above-named, the *one condition* modifying the rate of absorption, that is best appreciated and most easily controlled, is the degree of dilution of the drug by the stomach contents which must be absorbed with it. Thus, if the dose be given upon an empty stomach, with only sufficient fluid to ensure its solution and proper dilution, absorption should occur quickly, say in half an hour; while the same dose given after a full meal would require three to four hours for complete absorption, because of its diffusion through a quart or more of stomach contents which need that length of time for absorption. In the latter case only a part of the dose would be taken up from the stomach, as the contents with which it is mixed pass gradually into the duodenum, from which absorption continues.

It follows that, in order to produce a certain degree of effect, a larger dose will be needed when given with a full stomach than if given before a meal, for the degree of effect depends usually upon the amount of the drug circulating in the blood at one time. This amount will be determined by the quantity absorbed within a certain period, minus

the quantity eliminated during the same period. With absorption slow and elimination active (the elimination of some drugs begins very quickly), the amount present in the blood at one time may be much less than the amount administered.

As a rule, then, medicines will produce their effects with a minimum dose and in the shortest time (one-half to one hour) when given with the stomach empty. But some drugs are too irritating to be placed in an empty stomach. These will require great dilution. This is true of many of the salts, which diffuse easily, as a rule, and may be given with considerable water. Salts as irritating as the bromides and iodides should never be given without first being dissolved and well diluted.

When rapidity of action is unimportant, as with tonics and alteratives, we may as well give them after meals; except that bitter tonics, whose action is a local one upon the gastric mucous membrane, should be given ten or fifteen minutes before meals, in order to obtain their best effect. Cathartics are commonly given at bedtime so as to produce their effect at about the time of the usual morning evacuation.

Saline cathartics form a distinct class of medicines in relation to stomach administration, in that absorption is not necessary to their action. If given in concentrated solution upon an empty stomach their high degree of salinity (high osmotic pressure) will determine a flow of fluid from the blood into the digestive tract with prompt and copious watery evacuations. They are best given in the morning upon arising, as a prompt effect from a smaller dose may be thus obtained than when given at evening after a meal.

By the Bowel (Rectum and Colon).—Whenever, on account of inability to swallow or persistent vomiting, stomach administration is impossible, medicines or food may be introduced into the lower bowel. Also for local medication of the rectum or other organs located in the pelvis, as in cases of dysentery or of hemorrhoids, this method may be our first choice.

Form of Medicine.—The rectum does not provide for solution of substances to any degree. Therefore, if our object be general medication we must ensure solution of our drug. But if we desire local medication only, then absorption into the general circulation is unnecessary, and, indeed, may be undesirable; so we may have our drug in a condition to be taken up slowly by the tissues, the action being correspondingly prolonged. For general effect a non-irritating solution should be used in moderate or small quantity, so that it may not be expelled. In order to favor retention and absorption, it is advantageous to place the dose

high up in the colon. This can be done with a patient in the recumbent posture, by raising the hips above the level of the head. For local effect a solution or suppository may be employed.

Rapidity of Effect.—For general effect the action of a medicine by rectal administration is slower than by the stomach; but with conditions unequal—*i. e.*, comparing absorption from a full stomach with absorption from an empty rectum we may have a more rapid effect from the rectum. It is usually held to be true that the drugs which act upon the nervous system, *e. g.*, narcotics, may be given in a much larger dose by the rectum with safety.* This may be due partly to slow absorption and partly to the distance from vital centers of the site of absorption. A safe rule for most substances seems to be that the dose *per rectum* may be twice the dose *per orem*.

In addition to medication it is common practice, after severe surgical operations, to supply water to the system by rectum. An approved method is the Murphy method, by which fluid is introduced drop by drop, no more rapidly than the system absorbs it, and continued for hours or even days.

By the Skin.—We distinguish several methods, as follows:

Epidermic, where a substance is applied to the surface of the skin for the purpose of local medication or of counterirritation. When a systemic effect is desired a similar application may be made, with friction added, to secure penetration into the skin. Thus mercurial ointment is very commonly employed in the treatment of syphilis. The term *inunction* is applied to the use of ointments in this way.

Endermic, an obsolete method, which consisted in first raising a blister, then, after removal of the epidermis, in sprinkling a medicine intended for absorption upon the raw surface.

Hypodermic.—This method has assumed an importance which places it next to stomach administration. For promptness of action and definiteness of dose it is superior to all other methods, in the use of those drugs which admit of its employment. Also, on account of rapidity of absorption, the *dose* may usually be about *one-half* of the dose by the stomach. The method consists of the introduction of the medicine into the subcutaneous tissue by means of a small syringe

* Contrary to this, it is sometimes stated that strychnine is more poisonous when injected into the rectum than when swallowed. (Potter's Materia Medica, 1901, p. 391.) It is true that adrug absorbed from the lower part of the rectum will pass directly into the internal iliac vein and reach the heart and general circulation without passing through the liver, where its toxicity might be lessened.

armed with a hollow needle, through which the injection occurs. The pain of insertion of the needle deters from the use of this method for ordinary medication, and the dangers attending the injection, though slight, should require the greatest care in employing it. As a rule, this method will find its place in meeting the following conditions:

1. Inability to swallow, as when unconscious, or after local injury.

2. Any condition requiring the immediate action of a medicine, or absolute certainty of dosage.

3. Inability of the stomach to receive or retain the required medicine.

4. Conditions needing local medication, as in the employment of cocaine. In dental practice the injection method is well adapted to the need of securing local analgesia in many cases of extraction. A very short needle is here employed and the injection is submucous.

The hypodermic and submucous injection methods are limited to the use of soluble, non-irritating drugs. Stimulation, the relief of severe pain and the production of local analgesia comprise the common indications. The freely soluble alkaloidal salts in aqueous solution are well adapted, but alcoholic solutions are irritating. Tinctures are inferior on this account, but they may be used in emergency.

The dangers attending hypodermic or submucous injection are:

1. Septic infection.
2. Injection of air into a vein.
3. Injection of medicine into a vein, which might mean an overdose.

Septic infection may be due to lack of sterilization of the needle or of the solution employed. The result is usually formation of abscess. To avoid this danger the needle and syringe should be sterilized (by boiling if possible), and the solution be in boiled or distilled water and freshly made.

The *injection of air* into a vein would cause interference with the circulation through the lungs. The air, being carried to the right side of the heart, would be beaten up with the blood into a foam, by the action of the tricuspid valve. The air bubbles thus formed would not pass through the pulmonary capillaries; hence, the occurrence of embarrassment which might be serious, the condition being known as air embolism. An animal may easily be killed by injecting a moderate quantity of air into one of its veins.

To avoid this danger the syringe should always, before injecting, be held with the needle upward, gently tapped so as to dislodge any air bubbles within and cause them to rise toward the needle, and the plunger then gently forced onward until all air has escaped through

the needle. The presence of a little air in the subcutaneous tissue would usually be harmless, the danger being in the possibility of puncturing a small vein and forcing air therein. With this possibility is connected the next danger, that of *overdose* caused by throwing the whole quantity of the drug directly into the venous system. Our dose is intended for gradual absorption into the blood during a period of from five to fifteen minutes. If, instead, the whole dose is thrown immediately into the blood current and carried to the central nervous system, without the possibility of free dilution, poisoning may quickly occur. To avoid this accident, it is commonly recommended to insert the needle deeply enough so that it may be withdrawn a short distance, so as to escape any vein that might have been punctured in its course. Another precaution and, in the writer's opinion, one of greater certainty is to inject slowly and note, at the end of the needle, the accumulation of the injected fluid, which should be easily felt by the finger. If the fluid disappears about as rapidly as it is injected, puncture of a vein should be feared, but if the fluid accumulates with the injection, so that a distinct swelling is felt at the point of the needle, nothing need be feared. With the injection of cocaine into the gums for local effect, the immediate blanching of the tissue about the point of the needle may assure one that the solution has diffused into the tissues. In fact, the danger of forcing the drug into a vein is much less with the usual submucous injection than with the hypodermic, because of the small size of the veins in the mucous membrane of the alveolar region.

The Hypodermic Syringe.—Many kinds of syringes are on the market. The older style of glass barrel and leather plunger syringe has the advantage of permitting a view of the liquid or bubbles of air within the barrel, but the disadvantage of being less easily sterilized. It also dries out easily unless in daily use. The newer style of all-metal syringe has the disadvantage of allowing no view of the interior, but it has the very great advantage of being easily sterilized by boiling the whole syringe. Glass syringes are now also used, but they require much care in handling. With any kind the needles may be sterilized by boiling, while a thorough cleansing of the syringe with boiled water after each use and frequent washing with 5 per cent. carbolic acid, followed by alcohol, will be sufficient care of the syringe. The needle should be thoroughly sterilized before each injection.

How to Give a Hypodermic Injection.—Having syringe, needle and solution sterile, the skin is best cleansed by first scrubbing with soft soap and water, then sterilizing by the application of 50 to 70 per cent.

alcohol, 5 per cent. solution of carbolic acid, oil of turpentine, 1:1000 solution of bichloride of mercury, or some other equally efficient disinfectant. The hands of the operator should be similarly treated. Making sure of the absence of air from the syringe, the latter is held firmly with the right hand while the thumb and first finger of the left hand grasp the skin and raise it slightly at the point selected. Into the prominence thus occasioned the needle should be quickly pushed in a direction nearly horizontal to the surface, and should penetrate to the depth of from one-third to one-half an inch or even more. It may be withdrawn slightly, so as to disengage the point, after which the injection is made slowly so as to avoid too great violence to the tissues by rapid distention, which may be painful. Diffusion and absorption may then be aided by gentle rubbing over the injected area.

The site of injection for general systemic effect may be upon any accessible portion of the body, care being taken to avoid any visible vein or the proximity of an artery or nerve trunk; but in case of collapse, when the circulation and activity of absorption are greatly reduced, the injection should be made upon the trunk rather than upon the extremities—*i. e.*, nearer the center of the circulation, so as to secure more rapid absorption. For local effect the site of injection admits of little choice, except to avoid important structures. When, however, the injection is for local analgesia the medicine is injected more superficially, directly into and beneath the skin or mucous membrane, the object here being to paralyze the sensory nerve endings, which are more abundant superficially. It is unnecessary to penetrate deeply into the tissue unless a deep operation requires it.

A word of caution must here be given regarding the danger of forming the habit of the hypodermic use of narcotics, especially morphine and cocaine. This particular method of drug addiction is more common than is usually known. The seductive effect of the drug is so quickly induced that the victim readily endures the slight pain of the injection for the sake of the agreeable result. It becomes the duty of every practitioner to guard his patient and emphatically himself against this danger. Self-administration of a narcotic in this way is an exceedingly dangerous practice and must never be encouraged.

Cataphoresis.—By this term is meant the introduction of drugs in molecular form into living tissue, by means of the galvanic current. Analgesics and alteratives may be employed for application to a limited area by this method. The positive pole applicator is saturated with a strong solution of the drug and placed directly over the part to be medi-

cated, the negative pole being placed indifferently upon the cutaneous surface, but avoiding the more sensitive tissue of the face. The drug is carried from the positive pole into the tissue.

This method, with cocaine as the drug, has been used to allay sensitiveness of dentine. Care must, however, be taken not to disturb the pulp by the employment of a strong current—5 to 10 volts should be the maximum strength for this purpose. It is also employed to anesthetize pulps previous to immediate extraction. Further uses of cataphoresis in dentistry are to carry bleaching agents into the tubuli of discolored teeth and iodine into soft tissues. A current of 25 to 40 volts can be used for bleaching purposes, and also to destroy the pulp of a tooth.

It has been recommended to cocainize the tissues about the roots of teeth in order to obtain painless extraction, but such employment of the method meets with little practical success.

Intravenous Injection.—In case of emergency it sometimes becomes necessary to inject a stimulating or restorative agent directly into a vein. The agent most used for this purpose is the physiologic or normal saline solution at blood temperature. This is a solution of 8.5 parts of sodium chloride in 1000 of sterile water. It corresponds to the blood serum in salinity, and is used to replace the latter when deficient, after severe hemorrhage or in collapse.

The intravenous method has come to be employed rather extensively also for the administration of salvarsan in syphilis and antitoxins in diphtheria and tetanus. The effect of the remedy is much more prompt and efficient when thus injected directly into the circulation.

Hypodermoclysis.—The introduction of a large amount of normal saline solution is most commonly accomplished by hypodermoclysis, or injection into the subcutaneous cellular tissue. From 1 to 2 pints are often employed once or twice daily for a number of days in succession. The indications for its use are great depression from acute disease, hemorrhage and loss of fluid from the system by severe diarrhea. The apparatus employed consists of a gravity- or fountain-syringe armed with a large-sized hypodermic needle. The latter is introduced through the skin of the selected site, usually the lumbar region or underneath the breast, and the fluid is allowed to flow slowly by the force of gravity into the loose subcutaneous tissue. The temperature of the solution should be somewhat higher than that of the blood so as to allow for cooling during the slow injection.

By the Lungs (Inhalation).—Only gases, vapors and finely atomized liquids may be employed by inhalation. The method is limited to the use of anesthetics, stimulants, antiseptics and a few volatile antidotes.

Although thus limited, it is the most rapid of all methods of medication. The great extent of surface, especially adapted for the absorption of gases, presented in the expansion of the pulmonary tract (estimated at 1000 to 1400 square feet) explains why the action of an inhaled gas or vapor is felt almost immediately. The method is adapted especially to general anesthesia where a rapid and profound effect is needed.

For practical use by inhalation a vapor must be non-irritating, except when stimulation is desired. Ammonia is frequently applied by inhalation in case of fainting, in order to stimulate the heart and respiration. It is irritating to the mucous membrane, and by this action it produces reflex stimulation.

For the purpose of local medication of the air passages, antiseptics and sedatives are frequently vaporized in connection with steam. Either the steam atomizer may be used, or the drug may be placed upon boiling water, from which the steam is inhaled. The most irritating cough may frequently be relieved by proper medication with this method, while even in pulmonary tuberculosis the local treatment by inhalation is now given an important place.

CHAPTER IV.

MODES OF ACTION OF MEDICINES.

The precise modes of action of all drugs upon the human system will probably never be understood. In the laboratory many medicines exhibit certain exact physical and chemical properties that are constant; and, while a knowledge of these will aid us very much in studying drug actions, their combination with biologic factors in the vital structures of the body brings about results that are variable, often indefinable, and peculiar as to individuals.

This topic will not be discussed in theoretic detail; but the simpler and better understood modes of action can be profitably illustrated by examples, if we are careful to remember that any explanation can only be partial in most cases, because the contributory vital factors so commonly defy our scrutiny.

Physical Action.—The simplest kind of medicinal action is that where *physical* properties alone are concerned. Glycerin applied to a denuded surface or to a sensitive mucous membrane furnishes an example of such, its primary action being simply the abstraction of water from the tissues, with slight irritation which the loss of water occasions. Alcohol has a similar action, although more irritating because of its stronger affinity for water accompanied by coagulation of albuminous matter. The irritation in each case continues until the abstracted fluids have been replaced by fluid from the adjacent tissues or from the blood. This local alteration in the fluid component of the tissues exemplifies a principle of wide application throughout the body; for as glycerin and alcohol abstract small amounts of water locally, so physical factors are also employed in the withdrawal of large quantities of fluid through the channels of elimination. In turn the fluid of the blood is restored by absorption of ingested liquids from the digestive tract or by taking up a certain amount from the tissues. In this way also waste products are removed from the cells of the tissues and in turn they receive fresh nutritive fluid from the blood. Much of this action we must attribute to *osmosis,* defined to be the property by which liquids and crystalline substances pass through animal membranes. This process takes place

between the cells and their surrounding fluid, as well as between the capillaries and surrounding media, and is essential to the course of medicines as they pass through the body. In emergency, as after a severe hemorrhage, the same principle calls for the hypodermic use of physiologic salt solution in quantity, in order that it may be taken up by the circulation. In the treatment of nearly every disease this same principle finds some application.

Any extensive interchange of fluids is brought about chiefly through the influence of what is termed *salt action*—*i. e.*, the behavior of saline solutions of different degrees of concentration in relation to the salinity of the serum of the blood, by which a flow of fluid to or from the blood is determined. The process of osmosis, as seen in the passage of fluids of different composition through a separating animal membrane, is the most important factor of salt action. Having the blood serum of a certain concentration within the vessels and a saline solution more concentrated without, the osmotic flow will be from the blood to the stronger solution, because of the higher osmotic pressure of the latter; on the contrary, a weaker solution outside of the bloodvessels, because of its lower osmotic pressure, will readily pass into the blood. Thus the administration by mouth of a concentrated solution of a saline cathartic will promptly cause a flow of serum from the blood current into the digestive tract (exosmosis), while pure water taken into the digestive tract would pass into the bloodvessels (endosmosis).

A single drug, potassium bitartrate, may illustrate both exosmosis and endosmosis: For if it be given in form of the salt with very little water it will attract a large quantity of water from the blood and so induce a cathartic effect; but if it be given in dilute solution, it will pass into the blood and be carried to the kidneys to be eliminated, where its action will be diuretic. Any solution that is indifferent in osmotic action—*i. e.*, having the same osmotic pressure as the blood serum—is called *isotonic*, one of higher osmotic pressure being *hypertonic* and one of lower osmotic pressure being *hypotonic*. The salinity of the blood is imitated in the physiologic saline solution containing 0.85 per cent. of sodium chloride, which is used hypodermically, intravenously, or by the bowel, as a restorative.

Electric Action.—Passing from purely physical influences, we recognize also *electric* relations in the action of many substances. It has been ascertained that most acids, bases and salts, when in dilute solution, as in the blood and tissues, are dissociated into **ions** of their elements or radicals, that these are charged with positive and negative electricity,

and that the solutions are capable of conducting electrical currents. The *ions* do not usually act as the pure elements; in fact, they often exhibit entirely different properties; *e. g.*, in the dissociation of sodium chloride, the chlorine, which in its free state is a poisonous gas, does not act as such, but as the electronegative chlorine ion, while the sodium, which in its free state is an irritant base, in the ionized form is non-irritating and provides one of the most abundant constituents of the body.

The practical relation of ionization to the use of drugs is important, as may be illustrated by the use of iodide of sodium or of potassium. Here the element iodine, which in a free state could be given only in small quantity because of its irritating quality, may be given in a 35-times larger dose without unpleasant effects.

The combination with the base renders the iodine less irritating and the subsequent ionization in dilute solution, as administered, permits its wide diffusion through the body in form of the iodine *ion*, which is comparatively non-irritating.

Little can be said of definite electric reactions as a part of drug action within the tissues. In fact, with most drugs it is impossible to fully separate the physical, the electrical and the chemical factors, blended as they are in the life action of the cells.

Chemical Acticn.—The *chemical* features of drug action can be very clearly demonstrated for certain substances of local use. In the tooth structure especially, where the vital factors are slight, about as definite chemical reactions can be obtained as in the laboratory. The science of bleaching teeth rests upon this fact, and thorough disinfection by chemical means is made possible. But also in the softer structures that possess greater vitality, the chemical reactions of drugs locally applied are often very evident, *e. g.*, the coagulant action of phenol and the corrosive action of strong acids and alkalies. These reactions and their chemical basis are more fully discussed in the chapter on Escharotics. A special line of medication where the action is purely chemical is the application of chemical antidotes in cases of poisoning.

Secondary Effects.—With many drugs we observe both primary and secondary effects. The secondary is more likely to be the desired or *therapeutic* effect, or to lead to it. To illustrate: The application of an irritant (tincture of iodine or mustard paper) to the gum to relieve toothache, will first cause *irritation* (primary effect), then *alteration of circulation* in the region will follow (secondary effect) and, pressure being thereby equalized, we have *relief of pain* (therapeutic effect).

However, this order does not always obtain in drug action, for with some drugs the first action is the desirable one and later effects are undesirable.

In the use of simple irritants and astringents we observe some of the *reactionary effects* of drugs. When we speak of *irritation* we mean a disturbance of tissue, or a reaction to a disturbance. *Inflammation* is a reaction of higher grade having, as a prominent feature, a local increase in the number of leukocytes (leukocytosis), which becomes general in an inflammation of any severity. This condition really represents a reactive increase in the protective and reparative resources of the blood and tissues, which may be an important factor in securing relief. The action of an irritant drug in the vicinity of an inflammation (counter-irritation) is believed to stimulate absorption by the lymphatics as well as a local increase of leukocytes. Thus the vital factor within the tissues aids in securing the therapeutic effect, and it may even influence the primary action of the drug. This factor is so variable that for most medicines the sum of the effects can only be learned by experience, and even then individual peculiarity (idiosyncrasy) may determine unexpected results.

Medicines intended for general systemic effects have a more obscure action, which can usually be judged only by the clinical results observed. In general, we may say that stimulants and sedatives influence *functions* chiefly and their action is *temporary;* while alteratives and restorative tonics influence the *structure of* tissues by entering into the composition of the cells, their effects being accordingly more *permanent.* Stimulants may irritate tissue primarily, inducing stimulation reflexly, or they may cause more rapid or more powerful discharges of energy in functional activity of the organ stimulated. Sedatives depress functional activity, usually by direct influence upon nerve tissue, and they easily cause poisoning in very susceptible persons. A more detailed discussion of the action of stimulants, sedatives and alteratives is given in the separate chapters devoted to them.

Untoward Effects.—All undesired results of drug action, whether simply unpleasant or positively dangerous, are known as *untoward effects.* For example, the pain incident to a blister, the nausea caused by some drugs given for other purposes, the constipation and headache following a full dose of opium and the depression caused by many pain-relieving agents, are all classed under this term. No small part of the prescriber's art lies in securing the desired, and avoiding the untoward, effects of his remedies.

Protective Reactions.—It is well known that the blood possesses, in some degree, protective properties against certain toxic substances; and one of the important developments in therapeutics has been the discovery that the protective resources may be increased by medication of a peculiar kind, or added to artificially. This involves the question of securing *immunity* or the production within the body of antibodies that are antagonistic to the germs of particular diseases. The means of securing this end differ somewhat with different diseases. Thus, immunity against smallpox is positively attained by inoculation with the *living virus* of the cowpox; while immunity against typhoid fever is secured by the injection of a *bacterial vaccine* or *bacterin*, which is a preparation of killed bacteria of the kind which causes the disease.

Vaccines are also employed in prevention and treatment of other bacterial diseases, the principle being that of stimulating within the body the formation of bodies that are antagonistic to the cause of the disease. We are dealing here with a protective reaction on the part of the tissues of the body, the process being a natural one under the conditions induced.

Antitoxins.—In some of the infectious diseases the blood reacts to the *toxic products* of the disease and develops an antitoxic body, which directly neutralizes the poison and determines recovery in favorable cases. This fact is made use of in the treatment of diphtheria and tetanus particularly. A strong antitoxin, which can be specific for the one disease only, is developed in the blood of a domestic animal, the serum of which is then kept in a preserved state for use when needed. When a diagnosis of diphtheria is made, this antidiphtheric serum is injected hypodermically or intravenously as early as possible, with the result commonly that the poison of the disease is perfectly neutralized. Antitoxins, being natural products of the blood, are harmless and may be used in strong dosage.

Phagocytosis.—The protective resources of the body include also the white blood cells, or leukocytes, which increase in number greatly in most fevers and infections. Aside from their function of repairing tissues, they have the power to destroy bacteria in the blood (phagocytosis) and thus they form a very important part of the body defenses. In this relation they are called phagocytes.

PART II.

LOCAL REMEDIES.

CHAPTER V.

DEPLETIVES.

DEPLETIVE measures are those employed to abstract blood or serum from an inflamed or hyperemic area, usually with the purpose of relieving pain or pressure. The indications for their use are:

1. Inflammation that is painful or that threatens extension or destruction of tissue.
2. Passive congestion of a part that interferes with its function or with resolution of disease.
3. Simple hyperemia, when its continuance is likely to produce serious disturbance of tissue or function.
4. In local poisoning of tissues, as from the bite of an animal, or from local absorption of arsenic.

A depletive measure need not always remove blood or serum from the body. It may draw it from the point of disease into another part.

FIG. 1.—Dry cups applied to the chest, as in a case of pulmonary edema, the early stages of pneumonia, or diffuse bronchitis. (Hare.)

Dry Cupping consists in the application, to the surface of the skin, of glass cups from which the air has been exhausted. An alcohol flame

passed quickly into the cup immediately before applying, is the means commonly employed to exhaust the air. The vacuum permits the skin and underlying tissue to bulge into the glass and to become congested with blood. In this way, with each cup nearly or quite a tablespoonful of fluid may be drawn from deeper tissues to the skin and just beneath it. With the employment of a number of cups a very decided influence upon a deeper-lying inflammation is noticed, but no fluid is removed from the body. This method is of great value in conditions of pulmonary congestion or pneumonia, and a number of cups may be applied, and repeatedly, to the surface of the chest. The cups cannot be applied upon an irregular surface.

Wet cupping is accomplished by applying the same principle after first scarifying a limited surface with an ordinary lancet, or with the especially adapted spring lancet. The cup can then be applied as in dry cupping, or a special cup with an exhaust syringe attached may be used. The latter permits of a more constant vacuum being maintained. The vacuum allows a free flow of blood into the cup. By this method a considerable quantity of blood may be abstracted from any part of the body.

Scarification with a lancet is the method of depletion most commonly used in dental practice. The indications are hyperemia, inflammation, passive congestion, and local poisoning, as by arsenic. After scarification, bleeding may be encouraged by holding warm water in the mouth, while cold water will tend to lessen the flow.

The precautions to be observed in scarification are: Strict asepsis, guarding against too extensive a wound by a sudden movement on the part of the patient, and avoiding the proximity of vessels, nerves, or of Stensen's duct opposite the first superior molar.

Lancing of the gums over advancing teeth is called for when unusual hyperemia or swelling is present, or where general irritability, fever, or convulsions point to a local irritation which is found in an abnormal eruption of the teeth. It must be borne in mind, however, that sources of irritation may exist in other parts of the digestive tract, and that in a dentition which is progressing normally there is seldom any need of scarifying the gums. When employed, the incision should be directly over the advancing margins of the teeth.

Leeching.—The application of a leech (*Hirudo medicinalis*) is a convenient and efficient means of abstracting blood from a local point

for the relief of acute inflammation or congestion. For use in the mouth it is not generally applicable, on account of the aversion, on the part of some people, to having a leech in the mouth. Nevertheless, it is to be considered among the best means, and if employed with a leech tube so that it does not touch the tissue except by its sucker extremity, the objection is minimized. The leech tube is of glass, of a proper size to admit the leech and allow its distention by blood. It is drawn to a narrow opening at one end. This smaller opening should be large enough to permit the passage of the smaller end of the leech by which it makes suction. Swedish leeches are mostly employed on account of their large size, their capacity for abstracting blood varying from one-half to two fluidrachms (2 to 8 mils). If the leech does not bite readily it may be advisable to make a puncture with a fine point at the selected place, in order to obtain a small drop of blood upon the surface. This will usually induce the leech to bite.

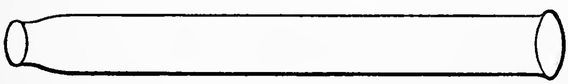


Fig. 2.—Leech glass.

The suction may be interrupted at any time by sprinkling a little salt upon the leech, when it will drop off. The leech bite is V-shaped and clean cut. Bleeding may continue for some time, and may even require the use of strong styptics or pressure in order to check it. When applied to the skin a small triangular scar invariably remains from the leech's bite, therefore, when used upon the face or neck, the point of application of a leech should be where the scar will not be noticeable, as under the chin, behind the ear, at the angle of the eye or nose, within the hairy region, or at the site of a natural wrinkle.

As related to all means of local bleeding it must be borne in mind that the hemorrhagic diathesis (*hemophilia*) is an *absolute contra-indication* to their employment.

Venesection or Phlebotomy.—General bloodletting is accomplished by opening a vein (usually the cephalic, just at, or above the bend of the elbow). This therapeutic measure was much abused in earlier years, and the natural reaction resulted in its almost complete abandonment. At the present time, however, it is often employed as an emergency procedure, in cases of severe toxemia or physical embarrassment of the circulation. A pint or more of blood may be drawn. The flow is easily stopped by the simple pressure of the dressing applied.

In order to find the vein readily and to secure its distention and consequent free flow of blood, a bandage is first placed around the arm just below the shoulder and drawn tightly enough to obstruct the venous return, but not to interfere with the arterial flow. This causes a fulness of the vessels of the arm and great distention of the veins. The median cephalic is then exposed with aseptic care and the opening made with the ordinary sterile lancet.

General depletion is also secured by means of sweating or by free catharsis. In either case it is possible to withdraw from one to three pints of serum from the circulation within a short time, which result may be a considerable factor in lessening a local hyperemia or inflammation. Sweating is most readily induced by the hot-air bath, taken either sitting (cabinet bath) or lying down (hot-air bed bath). The hot mustard foot bath also is efficient, adding to the sweating the derivative rubefacient effect upon the lower limbs.

A depleting catharsis is secured by the action of a quickly acting hydragogue, such as jalap, croton oil, and the saline cathartics. The salines are most commonly used. When given in concentrated solution (hypertonic, see p. 51) upon an empty stomach, they act promptly by causing a copious flow of serum from the bloodvessels into the digestive tract, followed by evacuation without much irritation. The state of blood-pressure modifies their activity somewhat, a fulness of the circulation favoring an outward flow of serum. A low blood-pressure would require salines to be given in larger quantity for the same desired result.

The vegetable hydragogues are, as a rule, more violent and drastic in action, because they irritate the bowel and greatly stimulate peristaltic action. Jalap is milder than others, and very efficient when simple depletion is desired, and it may be used daily for some time; but when a revulsive action is wanted the more irritating croton oil is used.

General depletion, as above, is indicated where there is accumulation of serum in a serous cavity, as the pleural or peritoneal, or where cardiac or hepatic disease is attended with marked venous congestion.

CHAPTER VI.

COUNTERIRRITANTS.

COUNTERIRRITATION means the production of an irritation in a normal part of the system in order to influence a diseased part favorably. The irritant is usually applied to the skin, but it may be applied to the mucous membrane of the mouth or to other accessible mucous surfaces. The action varies in degree from a simple reddening of the skin, by increase of the circulation locally, to a destruction of the superficial layer of tissue. According to the degree of irritation following their application, the agents are divided into:

1. *Rubefacients,* agents that produce redness of the surface.
2. *Vesicants* or *epispastics,* agents that irritate sufficiently to cause an exudate of serum beneath the epidermis (a blister).
3. *Escharotics, caustics* or *corrosives,* agents that destroy tissue.

The same agent may be a rubefacient, a vesicant or a caustic, as determined by the strength and duration of its application. This may be illustrated by the application of heat to the skin. Moderate heat will cause a dilatation of the cutaneous bloodvessels, with a decided hyperemia (rubefacient effect); a higher degree of heat will determine the escape of serum from the engorged vessels to the extent of lifting up the non-vascular epidermis (vesicant effect); and a degree of heat that will burn will cause destruction of the skin (escharotic effect).

Agents will be selected, therefore, for the degree of effect desired. While some of them will produce any of the above effects, others are more limited and fall naturally into only one class. Thus, arsenic acts slowly, and it cannot be said to produce any typical effect other than escharotic; capsicum usually produces only a rubefacient effect. It must be noted, however, that the thickness and texture of the skin will cause a difference in effect, from the same application, in different individuals, and in the same person upon different parts of the body. A thin, tender skin will blister much more easily than a thick, tough one.

It must also be noted that the same irritant will have a much severer effect upon the mucous membrane than upon the skin, on account of the softer and looser texture of the former; *e. g.,* tincture of iodine by a single application will only irritate the skin slightly, but it will quickly corrode and destroy the superficial layer of a mucous membrane.

The severer degree of counterirritation (*i. e.*, blistering) should be avoided both in childhood and in old age, because of the greater susceptibility to irritation and the lower vital resistance at the extremes of life.

Several rules may be wisely observed as to the site of application of a counterirritant in typical conditions:

1. If an inflammation is quite superficial, the counterirritant should be applied at a short distance. If applied immediately at the point of inflammation, the latter may be aggravated.

2. If deep inflammation is to be treated, the irritant is applied directly over, so as to induce a flow of blood to the surface and away from the deeper point of disease.

3. In case of neuralgia or neuritis, the irritant may be applied with best effect directly over the origin of the affected nerve, or at the point of its emergence.

4. In treating affections about the face and head, the irritant may be applied back of the ear, beneath the chin or upon the back of the neck.

Modes of Action of Counterirritants.—The remedial effect of a counterirritant is probably brought about by a threefold action. They influence: (1) The circulation; by causing a hyperemia through vasodilation at the point of irritation the tendency of the blood supply will be in that direction. (2) They turn the attention of the system toward the new point of irritation and away from the disease, partly a mental effect. (3) They influence the innervation of the diseased part by the reflex influence of the irritation. In the sum of their effects they stimulate the movement of fluids within the tissues; hence, they are regarded as lymphatic stimulants and are often employed to stimulate the absorption of serous or inflammatory exudate.

The terms *derivative* and *revulsive* are often applied to the action of counterirritants, the latter of the two referring especially to a very decided action, as in the prompt and violent effect of croton oil as a cathartic, when given to relieve a cerebral condition.

Heat.—This agent has an important place as a counterirritant, because of the readiness and variety of forms in which it can be applied. The hot-water bag, dry and moist poultices, hot foot and sitz baths, the hot iron, the thermocautery and the galvanocautery indicate the range of methods and effects that attach to the use of heat.

The irritant drugs, other than escharotics, are here discussed in the order of their severity, beginning with the mildest. Escharotics are considered in a separate chapter.

Capsicum.—CAYENNE PEPPER.—The fruit of *Capsicum frutescens*. Preparations and doses:

Oleoresina capsici, gr. ½ (0.03 gm.).
Emplastrum capsici—external use.
Tinctura capsici, ♏ 8 (0.5 mil.).

The most irritating preparation of capsicum is the oleoresin, which is seldom employed undiluted. The tincture may be applied to the mucous membrane in sluggish or atonic conditions. It acts by irritating, and thereby inducing a more active local circulation. Diluted with water, it may be used as a wash or gargle. The official plaster is prepared by spreading the oleoresin upon resin plaster. It is used as a counterirritant to the skin or, in a limited area, to the gums, as in the beginning of pericementitis. The powdered drug is likewise recommended as a dental counterirritant. To limit and concentrate its action it must be enclosed in a small sack, and in this way it may be combined with other drugs if desired.

The drug and its preparations are capable of causing irritant poisoning if taken internally in large doses.

Sinapis Alba.—WHITE MUSTARD.—The seed of *Sinapis alba*.

Sinapis Nigra.—BLACK MUSTARD.—The seed of *Brassica nigra*. Preparations and doses of black mustard:

Emplastrum sinapis (*mustard paper*)—external use.
Oleum sinapis volatile, ♏ ⅛ (0.008 mil.).
Powdered mustard (as emetic), ʒ2½ (10 gm.).

These two drugs are similar as to constituents and uses, although the black is the more powerful and claims our chief attention. Mustard in a dry state is not irritating, but the black mustard seed contains a glucoside, *sinigrin* and an enzyme, *myrosin*, which, in the presence of water, react to form the very irritating volatile oil (*oleum sinapis volatile*). Myrosin in aqueous solution coagulates at 140° F. (60° C.); therefore, a temperature of that degree or higher will prevent the development of the volatile oil. Alcohol and acids also interfere with its production. Water at ordinary temperature is the agent to use to develop the valuable constituent of the drug.

Taken internally mustard is an excellent emetic, the effect being due to its irritation of the stomach. In case of poisoning by opium or arsenic, or, in fact, by any except the most irritant poisons, if the case is seen early while the poison is still in the stomach, a tablespoonful of mustard stirred up in a glass of water and taken *at once* is a most efficient emetic. Mixed with enough water to form a paste, mustard

is applied between two layers of muslin to produce quick and moderate counterirritation, which, if prolonged, may proceed to vesication. For a continued rubefacient effect, the mustard may be diluted by mixing with from one-fourth to half as much flour before adding water. A mustard plaster or poultice thus prepared is called a *sinapism.*

The irritant power of this drug makes it a valuable addition to the hot foot bath. Here the mustard is to be stirred up in cold water, and the mixture allowed to stand for several minutes, then added to the hot water for the bath. In the treatment of pericementitis or other active inflammation in the upper part of the body, the hot mustard foot bath, carried to the point of thorough relaxation and sweating, is a valuable general measure. In similar conditions of inflammation about the face or mouth a mustard plaster may be applied to the back of the neck. A preparation of some value to the dentist is mustard paper (*Emplastrum sinapis*), in which powdered black mustard, freed from fixed oil, is mixed with a solution of india-rubber, and spread upon paper or upon cloth. Protected from moisture, mustard paper will keep indefinitely, and it may be found at any time ready prepared in the stores. For local blistering of the mucous membrane in the treatment of pericementitis, it is cut into small squares or other suitable shapes and applied directly to the gum over an offending tooth. The moisture of the mouth will cause the volatile oil to develop quickly. It is very convenient also for more extensive irritation upon the surface of the body, but when used upon the skin the plaster must be moistened with water before application, so as to secure the reaction which develops the oil. Volatile oil of mustard may be used as an irritant, by being applied pure for limited effect, or diluted with alcohol for extensive effect; but it has a very rank odor which is objectionable.

Oleum Terebinthinæ.—OIL OF TURPENTINE.—The volatile oil distilled from turpentine. Dose of the rectified oil, ♏5 (0.30 mil.).

Crude turpentine is the solid oleoresin, or pitch, which exudes from the pine tree when the bark is cut. By distillation it is separated into the volatile oil of turpentine and a solid residue called resin or rosin. The oil is colorless, with a characteristic odor and taste, which become stronger and less pleasant with age and exposure to air. It is soluble in 5 parts of alcohol and in 1 part of glacial acetic acid. For internal use the rectified oil is preferred. It is neutral, while the commercial oil may be slightly acid.

Oil of turpentine is used mostly as a rubefacient over a large surface, as upon the abdomen or front or back of the chest. It may blister

if used full strength. The official liniment (35 per cent.) may be used, or a turpentine stupe employed. The latter is prepared by wringing a piece of flannel, about twelve inches square, out of very hot water, then distributing from ten to thirty drops of oil of turpentine upon it. It is then quickly spread out, while still hot, upon the surface to be treated, and covered with several layers of fabric. This may be renewed frequently so as to keep up a constant rubefacient action.

This drug is a useful general antiseptic, and it may be used to cleanse instruments or disinfect the skin, but the odor is objectionable to some. It has been employed as a local antiseptic, but is not used in dentistry to any extent; the old oxidized oil may be used as deodorant in moist gangrene of the pulp, to destroy the extremely unpleasant odor. It does not coagulate albumin, so that except for its unpleasant odor it might be an excellent penetrating antiseptic.

In poisoning by phosphorus this drug has long been regarded as a valuable chemical antidote, if administered while the poison is still within the digestive tract; but this is true only of an old, highly oxidized oil, the old, French oil being most valuable. Fresh oil of turpentine will dissolve phosphorus and must, therefore, be avoided.

Incompatibility.—It reacts violently with *bromine* or powdered *iodine*, and in contact with a mixture of *nitric* and *sulphuric* acids it will ignite.

Iodum.—IODINE [I].—A solid non-metallic element, found in sea-weeds and in natural mineral compounds, its chief commercial source being sodium iodate, obtained in Chili. The drug is seldom used internally except in form of iodides. Preparations and doses:

Liquor Iodi compositus, *Lugol's solution*, (5 per cent.), ♏ 3 (0.2 mil.).
Tinctura Iodi (7 per cent.), ♏ 1½ (0.1 mil.).
Unguentum Iodi (4 per cent.), external use.
See also Iodides.

All of these preparations contain potassium iodide.

Pure iodine occurs in bluish-black, rhombic plates, having a penetrating odor and sharp taste. It is slowly volatile, soluble in 12.5 parts of alcohol, in 80 parts of glycerin and freely in ether; also soluble in an aqueous solution of potassium iodide, although nearly insoluble in water.* These solutions are brown in color, while chloroform and carbon disulphide each dissolve it with a violet color.

* Iodine is soluble in about 3000 parts of water. According to the U. S. Dispensatory, eighteenth edition, its solubility in water may be increased, not only by potassium iodide, but by sodium chloride, ammonium nitrate and, to some degree, by tannic acid. The official tincture now contains 5 per cent. of potassium iodide, which renders the solution miscible with water in any proportion without precipitation.

Iodine in the form of the tincture is an irritant of great value, as applied either to the skin or mucous membrane. Upon the latter it should be used only to a limited extent, as it will quickly corrode the superficial layer. As a counterirritant to the gum in pericementitis, or irritated or inflamed pulp, it is invaluable. Iodine is a penetrating agent, although the alcohol in the tincture will coagulate albumin slightly. In common with other irritants it has the power to stimulate absorption by the lymphatics, which is regarded as a valuable part of its local action. The great advantages possessed by the tincture are promptness and limitation of its action. The alcohol *coagulates* the tissue, thus limiting action, and the excess evaporates quickly, leaving a dry surface. Where coagulation is a disadvantage, or where the action of alcohol is not desired, the compound solution may be used, but it is slightly weaker than the ordinary tincture. Churchill's tincture (N. F.)* is much stronger than the official tincture, and is too irritating for application to the mucous membrane. The favorite combination of equal parts of tincture of iodine and tincture of aconite may be used more freely, as in it the iodine becomes diluted and its irritant action counteracted somewhat by the aconite, which is a local sedative.† The brown stain produced by iodine makes it objectionable to use upon a visible surface, and it should never be used within a tooth, for fear of permanent staining of the dentine. Stains upon the hands or upon fabrics are easily removed by water of ammonia.

As an antiseptic and disinfectant, iodine is very efficient. The tincture diluted with an equal part of alcohol is used to sterilize regions to be operated upon in the mouth as well as elsewhere. The use of strong solutions in the mouth, except as a counterirritant, is to be

* $16\frac{1}{2}$ %. This differs from Churchill's iodine caustic (*Liquor iodi causticus*, N. F.), which is stronger still, containing about 25 per cent. iodine.

† A very useful formula is:

℞—Tincturæ iodi,		
Tincturæ aconiti	āā	f℥ij (60 mil.)
Chloroformi		ʒj (4 mil.)—M.

Note.—Boulton's solution (*Liquor iodi carbolatus*, N. F.) is a time-honored and generally useful combination of iodine and phenol, much weaker than the official preparations of iodine. Its formula is:

	Gm. or mil.	
℞—Tincturæ iodi compositæ	15	
Phenolis (liquefied by heat)	5 5	
Glycerini	165	
Aquæ	q. s. ad 1000	—M.

Expose to sunlight until it has become colorless.

condemned, on account of its destructive action on the tissues. Upon the skin the tincture may be used in full strength. It may be applied in strong solution to ulcers, but is quite painful. For cleansing abscess cavities the tincture or the compound solution may be used somewhat diluted, either applied upon cotton or injected carefully. It may also be carried into the tissues by cataphoresis, by which method it is very useful in treating pericementitis, pericemental abscess, and especially the affections of the pericementum that follow influenza (Hofheinz).

In selecting an iodine solution for use we should have in mind the distinctive qualities of each, as given below, for the three preparations most commonly employed:

	Comparative action upon mucous membrane.	Mixed with albumin.
1. Tincture of iodine, 7 per cent.	Most severe irritant; corrodes mucous membrane superficially and promptly.	Immediate coagulation due chiefly to the alcohol present.
2. Compound solution of iodine, 5 per cent. (Lugol's solution).*	Moderate irritant; does not corrode.	Coagulation slight, and slowly produced.
3. Equal parts of tincture of iodine and tincture of aconite.	Moderate irritant; corrodes more slowly than tincture of iodine alone, and sometimes only after several applications.	Immediate coagulation due chiefly to the alcohol present.

The tincture may be combined with carbolic acid, which, with full strength of each, increases the corrosive and coagulating action. Equal parts, or any desired variation from this, may be used. Such mixture diluted with alcohol or glycerin is a proper application to abscess cavities, ulcers, unhealthy gums in stomatitis, etc., as it will combine disinfectant, irritant and indirectly stimulant properties. When properly diluted the carbolic acid may contribute a local sedative effect.

Water can be used to dilute the official tincture, as the formula now includes 5 per cent. of potassium iodide, which will hold the iodine in

* The formula of Lugol's solution (*Liquor iodi compositus*) is:

		Gm. or mil.	
℞—Iodi		5	
Potassii iodidi		10	
Aquæ destillatæ	q. s. ad	100	—M.

The potassium iodide is needed to hold the iodine in solution.

solution. Such dilution is a very great advantage in some of the uses of the tincture. Iodine has a reputation as a stimulant to absorption by the lymphatics, in common with almost all counterirritants and alteratives, with the advantage that it belongs to both of these classes. To influence the absorption of indolent swellings or to reduce enlarged lymph nodes, either the tincture or Lugol's solution may be applied (the tincture possessing the very great advantage of drying quickly), although after a number of applications the skin becomes blistered or broken, when their use becomes very painful. A better preparation for continued use is the ointment (containing 4 per cent. iodine and 4 per cent. potassium iodide), which may be applied daily, with friction to aid absorption.

Decolorized tincture of iodine,* so called, is less irritating and less efficient than the other solutions, but it may be applied where the color of the latter would forbid their use. It does not dry readily upon the skin, which is an objection to its employment.

In poisoning by iodine the proper chemical antidote is starch, preferably in the form of starch paste. This should be given freely.

Incompatibility.—Free iodine is incompatible with *starch*, forming the blue iodized starch; with *oil of turpentine*, mixture with which may be followed by violent reaction.

Internally the drug is used mostly in the form of iodides, for the reason that these salts are much less irritating and therefore permit a much larger quantity of iodine to be taken. As an alterative it will be further discussed in the chapter devoted to that class of remedies.

Oleum Tiglii.—Croton Oil.—A fixed oil expressed from the seed of *Croton tiglium*, a small tree indigenous in India. A brownish-yellow oil, soluble in 60 parts of alcohol, becoming darker and more soluble with age. It has an unpleasant, fatty odor and an acrid taste.

Average dose, ℳ 1 (0.05 mil.).

Croton oil is an irritant, whether applied to the skin or taken internally. When rubbed into the skin it acts slowly, producing in from twelve to twenty-four hours a crop of small vesicles, which are distinct and separated from each other. If undisturbed, these dry without breaking. The counterirritant effect is pronounced, with much less discomfort than from cantharides. The drug may be applied back

* *Tinctura iodi decolorata* (N. F.) is prepared with the aid of sodium thiosulphate and stronger water of ammonia. Because of the chemical change attending the decolorization, it contains no free iodine, but is a variable mixture containing chiefly ammonium iodide.

of the ear in treatment of severe or chronic inflammations about the face or mouth. It should be rubbed well into the skin. It may be mixed with equal parts of tincture of iodine for combined effect, but about the head it will generally be used alone.

Internally the oil is a drastic cathartic, poisonous in very moderate quantity, thirty minims (2 mils.) having caused death. In the usual dose of one-half to two minims (0.03–0.12 mil.) it irritates the intestinal tract, producing purging in from one-half to two hours. On account of its prompt action it is often given for revulsive effect in cases of cerebral hemorrhage or inflammation, and in uremic poisoning. Care must be taken in handling croton oil, and it should never be tasted.

Cantharis.—CANTHARIDES (Spanish Flies).—The dried insect, *Cantharis vesicatoria*. Obtained in various European countries, the large Russian flies being preferred. Average dose of tincture, ♏︎$1\frac{1}{2}$ (0.10 mil.)

As a counterirritant, cantharis is used in the form of the cerate applied as a plaster to the skin (*Emplastrum cantharidis*), or the cantharidal collodion, which is applied as a varnish.

The cerate produces in about twelve hours a single blister, the full size of the application, painful, and giving a maximum of counter-irritant effect. Seldom should a space larger than one by three inches be covered. Either the surface of the plaster or the skin should be oiled before applying, to ensure activity of the irritant principle *cantharidin*, which is soluble in oils.

The cantharidal collodion may be used instead of the cerate for ordinary application. It is believed to be safer, and it is much more convenient. It is applied as any other collodion, dries quickly and requires no dressing until the blister is formed.

There is some danger of absorption of the active principle, cantharidin, to avoid which the application should be as limited as possible. Irritation of the genito-urinary tract will be the first symptom of its poisonous general effect. The drug is reputed to be aphrodisiac in effect, but any sexual stimulation is due to irritation and is only one symptom of general poisoning, for cantharis is an irritant poison if taken internally in excessive dose. The tincture is the preparation for internal use, but it is seldom employed.

In case of poisoning by the drug in bulk, or by the cerate, no oil should be used as a demulcent, because of the solubility of the active principle in oils.

Chloroformum.—CHLOROFORM.—This drug is discussed fully in the chapter on Anesthetics, but it is mentioned here on account of its irri-

tant local action. This action is secured best when the vapor is confined. The "thimble blister" is a convenient form of counterirritation when it is to be limited to a single point. It is produced by placing a bit of cotton saturated with chloroform in an ordinary thimble and applying it closely to the skin for five to ten minutes.

Treatment of Blisters.—Bearing in mind that the healing of injured tissues is always a natural process, and that any application is to be regarded only as an aid, the simpler we make the treatment of blisters the better. This involves the simple principles of the treatment applied to burns, which may be stated as follows:

1. Cleanliness.
2. Protection from air.
3. Stimulation of repair.

The *first* is self-evident and requires only the simple statement that, as simple cleansing applications, any but the mildest antiseptics should be avoided. Boiled water, normal salt solution, and sterilized oils or fats answer the purpose of cleansing a blister in most cases.

In the absence of infection it is unnecessary to disturb the blister often, if proper protection is employed, as the natural process of healing may be disturbed by the daily removal of dressings, particularly when they adhere. Usually, when we are sure that the blistered surface is clean and aseptic, we can assume that healing will progress without interference. It is only in case of septic or unhealthy conditions that frequent treatment or strong applications may be needed.

The *second* is accomplished by the use of a demulcent such as a sterile oil or fat, or by any non-irritating protective agent, and the application of a dressing that will exclude the air. The contact of air is usually painful from its drying effect, and it presents also the danger of infection of the open sore.

Carron oil* is a time-honored application to burns and blisters, but an objection to its use is the fact that the drying of the linseed oil contained in it makes the dressing hard and often difficult to remove without disturbing the sore.

The *third* applies chiefly to large blisters that heal slowly, and includes such measures as the application of poultices of brewers' yeast, which is a most excellent cleansing and stimulating agent.†

* *Linimentum calcis*, composed of equal parts of linseed oil and lime-water.

† The great value of brewers' yeast in cleansing and stimulating repair of indolent and foul ulcers is believed to be due to the nuclein developed by the yeast plant.

When healing is much prolonged and hindered by the development of excessive granulations (proud flesh), the latter may be removed by a mild caustic, such as burnt alum, or scraped away. Such removal will often be followed by more rapid healing. The last resort is skin-grafting, which consists in transplanting pieces of normal skin from some other part of the body upon the denuded surface, after proper preparation. This will usually be successful in securing a satisfactory epithelial growth, with the usual cicatricial healing of the surface.

CHAPTER VII.

ESCHAROTICS.

Escharotics or *caustics* are agents that destroy tissue upon contact. Many attack the tissue immediately and are, therefore, called *corrosives*. It will be noticed that nearly all agents of this class are strong chemicals; that is to say, they are known and characterized by powerful *chemical affinities*. And this fact serves to explain why they are nearly all corrosives. They have so great affinity for one or more constituents of the tissues that they destroy the organic structure in order to satisfy it. It is further noted that they all differ somewhat in their effects upon tissue. This is explained by their *difference* in chemical affinity.* Thus carbolic acid has a strong affinity for albuminous matter; it cannot corrode deeply because the firm coagulum immediately formed prevents its penetration. Caustic potash, on the contrary, has no affinity for albumin, forms no coagulum, but penetrates deeply into the tissue, displacing weaker bases from their combinations. It also possesses an affinity for water. These affinities suggest the antidotes in case of poisoning by each. The antidote to carbolic acid will be albumin, that to caustic potash a dilute acid.

In the practical application of caustics we prefer those that combine efficiency and safety, with action self-limited or easily controlled.

The strong acids and alkalies are prominent, forming groups that are typical as to the nature and action of corrosives, but they are not usually the agents of choice because of the severity of their effects.

In the grouping that follows, chemical similarity, rather than similarity of action, is made the basis. This facilitates the study of chemical antidotes, which apply as well to groups as to individual substances. Some agents that cannot be thus grouped are considered in an unclassified list and their chemical relations studied separately.

* *Experiment.*—To compare the coagulant and non-coagulant action of caustics: Spread the white of an egg upon a pane of glass lying upon a dark surface. Place at intervals upon the albumen a drop of each of the mineral acids, of phenol, and of caustic soda or potash. Note that the alkali does not coagulate; the acids and the phenol do, but the coagula formed differ in firmness.

Mineral Acids.

Acidum Hydrochloricum.—Hydrochloric Acid (Muriatic Acid).—Contains 32 per cent., by weight, of absolute hydrochloric acid [HCl].

Acidum Nitricum.—Nitric Acid (Aqua Fortis).—Contains 68 per cent., by weight, of absolute nitric acid [HNO_3].

Acidum Nitrohydrochloricum. — Nitrohydrochloric Acid (Nitro-muriatic Acid, Aqua Regia).—Consists of 82 parts of hydrochloric acid and 18 parts of nitric acid.

Acidum Sulphuricum.—Sulphuric Acid (Oil of Vitriol).—Contains not less than 94 per cent., by weight, of absolute sulphuric acid [H_2SO_4].

Applied to living tissue mineral acids all *coagulate albumin,* but nitric acid more firmly than the others.* Sulphuric acid has also a marked affinity for water, and is accordingly the most powerfully corrosive, producing an effect very similar to an ordinary burn. They all have so great an affinity for bases that they disorganize the tissues in order to combine with them, hence their extremely poisonous effects.

The strong mineral acids are seldom applied to the mucous membrane because of the severity of their action. Upon the skin they may be applied directly to warts, for the removal of which a few daily applications usually suffice. For this purpose nitric acid is preferable, because slightly less severe in action than the others.

These acids are caustic to bone as well as to soft tissues, on account of their power to dissolve the earthy salts of bone. Accordingly, nitric acid has sometimes been applied to small foci of carious bone which were not accessible for removal. Its action may be checked at any time by the use of a weak alkali, such as sodium bicarbonate solution or lime water, which should be injected forcibly, so as to ensure the antidotal reaction at the point of the corrosive action of the acid, which may be at some depth. Employing in dental practice the solvent power of these acids upon mineral salts, they are sometimes applied, slightly diluted, within a small root canal to aid in enlarging the same. They act more rapidly upon partly decomposed than upon sound dentine. In fact the normal tooth structure seems to be little affected during the ordinary time of application; however, when the action has proceeded as far as is desired the acid should be completely neutralized. The range of strength of sulphuric acid, as mostly employed, is 20 to 50 per cent., depending upon extent of action required. Caution should be used to prevent its passage into the periapical region, for there

* See Experiment, previous page.

is no doubt that such strong agents predispose to the formation of abscesses by lessening the resistance to infection.

Internally mineral acids are employed only in diluted form. They are further discussed under the heading of Restorative Tonics.

Poisoning by Mineral Acids.—When a strong mineral acid is used for any purpose, it must be borne in mind that it is a dangerous substance, and great care must be exercised to guard against poisoning. The bottle should be labeled with a poison-label, such as pharmacists are required to place upon all powerful poisons. The dentist also should have a ready knowledge of first treatment in case of poisoning; for any treatment, to be of use, must be employed very promptly, or a fatal result may be expected. In the presence of a case of poisoning by a strong mineral acid, it is not essential to know just which acid has been swallowed. The important facts upon which to proceed are: (1) that the corrosive action depends chiefly upon the concentration of the acid; and (2) that the affinities of the whole group are so nearly identical that the same antidotal treatment will apply to all. The first and most important thing to do is to *dilute the poison freely by large draughts of water*. This will remove the danger of further corrosion, and, as water is always at hand, it can be employed immediately. The use of a chemical antidote must be secondary, because of the time usually necessary for its preparation, during which serious damage is being done by the corrosive poison if undiluted. But after free dilution the chemical antidote should be given, so as to completely neutralize the poison. An alkali will be selected, diluted if at all irritating, and given freely. Lime-water and magnesia are preferred to a carbonate, because the latter will, in reaction with the acid, give off a large quantity of carbon dioxide gas, which may cause painful distention of the stomach and even endanger its corroded wall. In emergency, soap, or plaster scraped from the wall, may be given. Vomiting generally occurs, and washing out of the stomach is facilitated by the early dilution with water as recommended above. The use of emetics or the stomach tube is open to question in these cases. Since the neutralization of the acids with simple alkalies results usually in harmless products it seems unnecessary to further irritate the stomach. Later treatment will comprise the use of demulcents, anodynes and stimulants. (See Table of Poisons and Antidotes.) The fact that poisoning by strong mineral acids is usually fatal, demands that emphasis be placed upon immediate treatment, as outlined.

Organic Acids.

Acidum Acetum Glaciale.—GLACIAL ACETIC ACID [$C_2H_4O_2$].—Nearly or quite absolute acetic acid, being not less than 99 per cent. It is liquid or crystalline, according to the external temperature, its melting-point being a little below 60° F. It is colorless and has a strong vinegar-like odor and a sharp acid taste. It is *not a coagulant,* but, on the contrary, is a *solvent* of albuminous and fibrous tissue. It is employed only as a caustic and to soften callous tissue. It is not used internally.

Acidum Trichloraceticum.—TRICHLORACETIC ACID [$C_2HO_2Cl_3$].—It should be not less than 99 per cent. Obtained by oxidation of chloral hydrate with fuming nitric acid and subsequent distillation, it occurs in colorless crystals that are very deliquescent. It is soluble in 0.1 part of water and very soluble in alcohol and ether. Either in crystals or strong solution it is used as a caustic to remove redundant tissue, as overhanging gums, warts, etc. It *coagulates albumin,* and may be employed as a test for that substance. A 20 per cent. solution is recommended as an application to chronic inflammations of mucous membranes. In full strength it may be applied to the gum tissue to prevent exudation of moisture, the so-called "weeping gums," during filling or setting of a crown.

In the treatment of pyorrhea alveolaris this drug may be applied in from 90 per cent. down to 5 per cent. strength—the strongest solution first, as a powerful escharotic, and the strength then gradually reduced to that which is astringent and antiseptic, having the added advantage in any strength of its solvent power upon the calcareous deposits. It is also used to obtund sensitive dentine.

Acidum Lacticum.—LACTIC ACID.—A colorless, syrupy liquid containing 85 to 90 per cent. of absolute lactic acid [$C_3H_6O_3$]. It is obtained by lactic fermentation of milk-sugar or grape-sugar. It is strongly *acid* in reaction, freely miscible with water, alcohol, or ether; insoluble in chloroform. It does *not coagulate* albumin, but may be employed as a *solvent* to fibrinous exudates, as in diphtheria, a 20 per cent. solution being applied. A solution of 20 to 50 per cent. may be used in the treatment of pyorrhea alveolaris to soften remnants of calculary deposit in the tooth socket.

Caustic Alkalies.

Aqua Ammoniæ Fortior.—STRONGER WATER OF AMMONIA.—A 28 per cent. solution, by weight, of ammonia gas [NH_3] in water. This solu-

tion is not used medicinally to any extent, but it is the basis for the preparation of spirit of ammonia. It is a volatile caustic, the vapor being extremely irritating to the air passages. The United States Pharmacopœia directs that it should be kept in strong, glass-stoppered bottles, not completely filled, in a cool place. The bottle should be opened cautiously with its mouth directed away from the face; and if the temperature is warm, the bottle had better be cooled before opening, as otherwise the gas may be under considerable pressure. In case of accidental swallowing of this caustic, symptoms of irritation of the respiratory tract, with dyspnea, will be prominent. This will call for a volatile antidote in addition to the free dilution of the poison by water. The proper antidote will be the vapor of strong acetic acid, in the absence of which strong vinegar may be swallowed and its vapor inhaled. Stronger water of ammonia is a powerful saponifying agent. It does *not coagulate* albumin. The ordinary water of ammonia (10 per cent.) may be prepared from this stronger solution by diluting with twice its volume of water.

Potassii Hydroxidum.—Caustic Potash.—*Potassa.*—*Potassium Hydrate* [KOH].—85 per cent. at least.

Sodii Hydroxidum.—Caustic Soda.—*Soda.*—*Sodium Hydrate* [$NaOH$].—90 per cent. at least.

Potassa and soda are the only caustic alkalies used in dental practice, and these very seldom. They are prepared in form of sticks, which deliquesce readily and must, therefore, be kept in tightly-corked bottles and must not be handled without protection of the fingers. Their affinities are for water and acids. They do *not coagulate* albumin, therefore their penetration is unhindered. They corrode deeply, causing severe pain. They are in no respect superior to iodine and carbolic acid as superficial caustics, and accordingly have little to recommend them at the present time. Their action is more easily controlled than that of arsenic, as they can be completely neutralized by weak acids. They may be useful in the place of arsenic for the removal of small tumors.

In poisoning by one of the caustic alkalies the usual rule of giving water freely to dilute the poison applies, with the additional advantage that water satisfies one of the affinities of either soda or potassa. The chemical antidote to follow dilution is any dilute acid, giving preference to the less irritating vegetable acids, such as vinegar and lemon juice. (See Table of Poisons and Antidotes.) While only the strong alkalies are classed as escharotics, even the dilute solutions known as

liquor potassii hydroxidi and liquor sodii hydroxidi (not less than 4.5 per cent.) are decidedly caustic and irritating to mucous membranes. As an alkali soda is slightly stronger than potassa. Both are powerful saponifiers.

Unclassified Escharotics.

Phenol.—CARBOLIC ACID [C_6H_5OH].—Hydroxybenzene obtained from coal-tar or made synthetically, being of not less than 97 per cent. strength. The average internal dose is 1 grain (0.06 gm.) well diluted.

Phenol Liquefactum.—LIQUEFIED PHENOL.—87 per cent.

[*Crude phenol* is a liquid consisting of various constituents of coal-tar, having an odor resembling that of creosote. It is used only as a general disinfectant, never internally as a medicine.]

Phenol was discovered in 1834 by Runge, who gave it the name of carbolic acid. In chemical nature this substance is not an acid, but an alcohol, the term "acid" having been given to it probably on account of its corrosive action. It is only slightly acid to test-paper, and while it combines with a few bases, the resulting salts are so unstable as to be decomposed by carbonic acid. It is not capable of neutralizing alkalies. It is a definite, crystalline compound, with a distinct, sweetish odor, soluble in about 15 parts of water, very soluble in alcohol, glycerin, ether, chloroform and oils. The crystals liquefy easily in a warm temperature, and reform when the liquid is cooled; but a permanent liquid form may be secured by the addition of 5 to 10 per cent. of water or glycerin. By exposure the liquefied drug gradually acquires a pinkish and later a reddish or brownish color, which does not lessen its value.

According to Demant,* the color of phenol may be removed, and perfectly white crystals again obtained, by adding 11 parts of alcohol to 89 parts of the phenol, subjecting the mixture to freezing, and then draining off the portion remaining liquid.

As a caustic this drug differs from all others in having a *local analgesic effect* following a momentary irritation. Its most decided affinity is for albumin, which it *coagulates quickly and firmly,* thus limiting penetration beyond the superficial layer of tissue.† Its analgesic effect,

* United States Dispensatory, eighteenth edition, p. 37.

† *Experiment.*—To show the effect of phenol upon mucous membrane and the restorative effect of alcohol: Evert the lower lip and, after drying, touch two separate points each with the quantity of phenol that will adhere to the head of a pin. See the white coagulum form at each point. After half a minute dry the surface and apply a few drops of alcohol to one coagulum. Note the difference in the two points after a few minutes. Also observe the results next day.

combined with a superficial but decided corrosive action, makes it an ideal caustic for limited application to a mucous membrane. Extensive application might, indeed, cause inflammation and symptoms of poisoning, and must be avoided. Upon the skin the action is less energetic, although still quite caustic where the skin is soft or thin. In case of accidental contact with tissues, the effect may be mitigated by the immediate application of alcohol, as explained later in the discussion of poisoning.

The drug may be applied pure to ulcerated or denuded points, whether painful or not, with the result that any septic process present will be antagonized, and the coagulum formed will protect exposed nerve endings. Thus applied to canker sores, it will relieve the pain for a considerable time and check the bacterial activity. The sore should first be dried and just sufficient of the pure drug applied to cover well the ulcer. Several daily applications may be needed for complete relief.

Carbolic acid is not an efficient devitalizing agent, because it does not penetrate, and its superficial effect is not sufficiently irritating to induce engorgement of the deeper tissues. Only in deciduous teeth is carbolic acid made use of as a pulp devitalizer. Here a slower effect occurs from repeated applications, without the pain that may attend the use of arsenic and without any danger of systemic disturbance.

For disinfecting alveolar abscess and stimulating repair, a small quantity of pure phenol upon a pledget of cotton may be introduced after the abscess has been evacuated; or, in suitable cases, it may be pumped through the apex of the root into a pus tract and through a fistulous opening.

It is frequently used as a pulp dressing in case of toothache from exposure of pulp, but never when the pulp is to be conserved, on account of its destructive action upon it. It may also be applied to obtund sensitive dentine. It has been used to lessen the sensitiveness of the gums in order to apply a rubber-dam ligature far beyond the gum margin. But for this, as for nearly every purpose as an analgesic, it is inferior to cocaine, and has the further disadvantage of always destroying some tissue when applied strong.

The uses discussed thus far apply to the pure carbolic acid or a slight dilution of it. But the most important place of this substance in medicine is as an antiseptic, under which heading will be discussed its more general uses in diluted solutions.

Poisoning by Phenol.—The poisonous power of this drug is very great, as the recently numerous deaths by suicide show. The symptoms

of poisoning combine those of local injury to the lining of the digestive tract, with shock and great depression of the nervous system, the latter often leading to death within an hour. The antidotes are *albumin* in the form of raw egg, or milk or flour paste as substitutes for it, and *alcohol*. Albumin furnishes material for the poison to act upon and expend its corrosive power in coagulation. It must be given early to be of use. It is a true chemical antidote. Alcohol is employed in phenol poisoning but it is not a chemical antidote. It seems to act upon the corroded tissue, lessening the destruction that would follow, its action being physiological rather than chemical.

It has been found that the hands may be immersed in pure liquid carbolic acid, and, if washed immediately afterward in strong alcohol, no harm to the tissues will result. Also, if carbolic acid be applied to the mucous membrane with the production of the white, superficial coagulum, and strong alcohol be then applied, the white spot will partly disappear and the corrosive action be much diminished.* An explanation of this antidotal influence of alcohol is found in its affinity for water, which it draws toward the surface, thereby furnishing more fluid for redissolving the coagulum and diluting any uncombined carbolic acid that may be present in the tissue. (See Table of Poisons and Antidotes.)

The poisonous effects of phenol are not limited to its local action upon tissue.† When it is absorbed in considerable quantity it gives rise to irritating products which may seriously damage the kidneys, liver and other organs. Fatty degeneration of various tissues has often been found postmortem. Corresponding to this action the urine in phenol poisoning often shows an olive-green or dark color. To counteract the systemic poisonous action it is advised that a soluble sulphate be given for some time, so that harmless combinations may be formed and eliminated; but the value of this treatment has been questioned, and by some authorities believed to have been disproved.

* See Experiment, p. 75 (note).

† In the Philadelphia Medical Times, vol. xi, p. 284, Taylor records a case in which a man, who was supposed to have swallowed about 1 ounce of carbolic acid, became comatose within three minutes and died within *four minutes* from the time of taking the poison.

In the New York Medical Journal, November 30, 1889, Richardson reports a case in which equal parts of carbolic acid and sweet oil, applied to a burn on the arm of a child seven months old, caused stupor in two hours, and death occurred, with convulsions, thirty hours after the application.

Death has followed the application to the skin of half an ounce of carbolic acid in watery solution, for the purpose of destroying parasites.—Wood's Therapeutics, eleventh edition, p. 563.

Several combinations of phenol deserve mention because of their modified action, which is at times desirable:

Camphorated phenol, or campho-phenique, consists of about equal parts of camphor and phenol, which liquefy when heated together. It is less soluble than phenol, and it does not corrode tissue. Used chiefly as a disinfectant canal dressing and as an obtundent.

Liquor sodii carbolatis contains 50 per cent. phenol (see formula, p. 128). It is somewhat caustic if used in full strength. It provides a strongly alkaline application for limited use as a disinfectant.

Chloral-phenol, prepared by triturating together with heat, 1 part chloral hydrate and 3 parts phenol. The product is an oily liquid which may be used as counterirritant and local analgesic.

Iodized phenol, consisting of a mixture of iodine and phenol in varying proportions, whereby the irritant property is increased. Equal parts of tincture of iodine and phenol is sometimes used as a counterirritant.

Argenti Nitras.—NITRATE OF SILVER [$AgNO_3$].—Dose, gr. $\frac{1}{6}$ (0.01 gm.).

Argenti Nitras Fusus.—MOULDED NITRATE OF SILVER.—*Lunar Caustic.*—Moulded sticks containing about 95 per cent. of silver nitrate.

Argenti Nitras Mitigatus.—DILUTED NITRATE OF SILVER.—*Mitigated Caustic.*—Moulded sticks consisting of 1 part silver nitrate and 2 parts potassium nitrate. (Not official.)

Nitrate of silver occurs primarily in colorless crystals, having a bitter, metallic, and somewhat caustic taste. Its aqueous solutions are *neutral.* From the crystals are prepared the moulded and diluted forms, which are in pencils or sticks convenient for application. All forms are freely soluble in water, the pure salt being soluble in 0.4 part and in 30 parts of alcohol.

This drug in any form or strength of solution turns dark upon exposure to sunlight. This is a standing objection to its use about the face, and especially about a carious tooth, the structure of which it may stain permanently if allowed to penetrate the dentinal tubuli.

A stain upon the skin remains until the stained epithelium is worn away. It cannot be removed sooner except by paring or scraping away the superficial layer, but the stain upon a fabric may be easily removed by a weak solution of potassium cyanide. The prolonged internal use of silver in any form may cause a permanent blueness of the skin called *argyria.*

As a caustic its action depends upon its affinity for albumin, it being *a decided coagulant.* Its application causes an irritation that continues

for some time, but the effect is quite superficial because of the coagulum formed, which hinders penetration. It has long been used to cauterize wounds that are probably infected, such as dog bites and dissection wounds, but it must be regarded as *poorly adapted* to this use. It does not penetrate deeply, therefore cannot be relied upon to destroy the infected tissue, and it, moreover, by coagulating the surface, checks hemorrhage that might be useful in washing away the infectious matter, and it seals in, as it were, the point of infection. Its use, therefore, as a cauterant for deep, infected wounds must be condemned.

It is one of the most irritating caustics to the mucous membrane, on account of the added effect of a small amount of nitric acid liberated by the coagulant reaction.

The field of usefulness of this drug is for superficial effect upon invisible surfaces, where it is desired to have the irritation pronounced or productive of a secondary stimulation of the local circulation. According to the degree of action desired it may be applied in the pure stick of lunar caustic, the stick of mitigated caustic, or in aqueous solution of 1 to 10 per cent. strength, the weaker solutions being astringent rather than caustic. It is frequently applied to abort acute inflammations and as a stimulating caustic to indolent ulcers.

In dental practice silver nitrate is used to check caries in temporary teeth, where filling is impracticable. It was first recommended for this purpose by S. Stebbins, in 1891. Szabo, of Budapest, has made the most extensive scientific study of this action. He found by experiments that:

1. It penetrates one-half millimeter ($\frac{1}{50}$ of an inch) into the dentine.
2. The albumin unites with the metallic salt in form of a precipitate.
3. Granular albuminate is formed which the action of light darkens.
4. It finally becomes black and insoluble.

For the purpose stated it is applied either in pure form, or in saturated aqueous solution, at the point of decay. The fused stick may be employed, or some of the crystal may be melted upon a heated platinum point and carried to the tooth, as recommended by Craven; or a silver wire dipped in nitric acid may be used. Holmes* advises, for approximal cavities, to carry the powdered crystal adhering to a piece of gutta-percha, which has been softened by heat, of proper size to remain in the cavity. The silver nitrate is thus retained for a long time.

* Dental Cosmos, 1892, p. 982.

Because of its coagulant power it may also be used to obtund sensitive dentine in cavities that are not visible, where the staining would be less objectionable. Its distinctive antiseptic value is discussed under Antiseptics.

Incompatibility.—With *albuminous matter* coagulation occurs; with *hydrochloric acid*, soluble *chlorides*, or *chlorine* solutions, a precipitate of chloride of silver occurs; in contact with most *metals* it is reduced to metallic silver; an aqueous solution acidulated with *nitric acid* and heated with *alcohol* will form the explosive "fulminating silver."

In poisoning by silver nitrate the chemical antidotes are *albumin* and *sodium chloride*. The latter forms with it the insoluble chloride of silver. In case of the use of the drug locally any excess may be at once removed by sodium chloride solution. (See Table of Poisons and Antidotes.)

Hydrogen dioxide [H_2O_2], in very strong ethereal solution (25 per cent.), is a caustic, but its uses as such have not been very definitely developed as yet. It is used chiefly as a bleaching agent. Care must be taken in handling this strong solution to avoid its action upon the hands. Oiling will protect the skin from its action.

Alumen Exsiccatum.—Dried Alum.—*Burnt Alum* [$AlK(SO_4)_2$]. Alum, by being deprived of its water of crystallization, is changed from an astringent to a mild caustic. It has little influence upon firmly organized tissue. It is used chiefly to destroy excessive granulations in wounds or ulcers, the so-called "proud flesh." The powder is applied directly.

Cupri Sulphas.—Sulphate of Copper.—*Blue Vitriol* [$CuSO_4+5H_2O$]. As a mild caustic the pure crystal may be applied to mucous membranes, the typical condition for its use being found in granular eyelids. It is *acid* in reaction. In strong aqueous solution it has been applied to pyorrheal pockets, but here it is an inferior agent because of the danger of discoloring the root and tooth. It is likewise astringent, and is more fully considered in that relation. (See under Astringents, also Table of Poisons and Antidotes.)

Chromii Trioxidum.—Chromic Anhydride.—*Chromic Acid* [CrO_3]. It occurs in purplish-red crystals, which are soluble and deliquescent, forming chromic acid. Alcohol decomposes it sometimes with explosive violence. It is an energetic caustic, but rarely used.

Zinci Chloridum.—Chloride of Zinc [$ZnCl_2$].

This substance occurs in white powder, or in irregular masses or fused sticks, all of which are intensely caustic and dangerous to taste,

and *acid* in reaction. The salt is very deliquescent, therefore the drug may commonly be in either solid or liquid form. It is soluble in 0.3 part of water and very soluble in alcohol. Used pure it is a very energetic caustic. Its affinities are for water and *albumin*, therefore its action is prompt, producing a firm, white eschar. It is held to be the most penetrating of all coagulants. The official liquor zinci chloridi (50 per cent.) may be employed, or a stronger solution prepared, as a penetrating *coagulant agent* within the structure of the tooth. After removal of the pulp it will efficiently disinfect and coagulate the contents of the tubuli. Indeed, in the stronger solutions, it is used more in treating tooth structure than soft tissues, on account of the pain attending its action upon the latter.

It has long been used in full strength to lessen the sensitiveness of dentine. Its action is not a simple one, but is based upon its affinity for water and its coagulant power, to which is added the irritant influence of a small quantity of hydrochloric acid liberated in the coagulant reaction. Care must be taken not to apply it so near the pulp as to produce irritation; and repeated applications may be needed as excavation proceeds. When irritation of the pulp is feared from its use, the cavity should be at once irrigated with tepid water. It is one of the agents used to cauterize and stimulate the closure of alveolar pockets about the roots of teeth in cases of recession or pyorrhea.

In addition to its other dental uses, it is very effective in the treatment of *chronic alveolar abscess*. It should be applied directly to the abscess cavity through the root canal or through an external opening. It is very painful for a short time when first applied. In addition to its escharotic action it produces considerable irritation, thereby setting up an active inflammatory process which hastens resolution. For this purpose it may be used in a solution varying in strength from 10 to 50 per cent.

The following is recommended when the aqueous solution proves very painful:*

	Gm. or mil.		
℞—Zinci chloridi	2	60	(gr. xl).
Alcoholis,			
Chloroformi . . . . āā	15		(f℥ss).—M.
			(Hofheinz.)

In the weaker solutions (1 to 20 per cent.) it is astringent and antiseptic, and further discussion of its uses will occur in the chapters devoted to those classes of agents.

* Dental Cosmos, 1903, p. 31.

It must be ranked as a corrosive poison. The preparations likely to cause poisoning are the full strength liquid, the 50 per cent. solution, and the popular "Burnett's disinfecting fluid," which contains 200 grains to the fluidounce (about 42 per cent.). The chemical antidotes are *albumin* and dilute solution of *sodium* or *potassium carbonate*. (See Table of Poisons and Antidotes.)

Incompatibility.—The drug is incompatible with the antidotes mentioned above and with *nitrate of silver*.

Chloride of zinc in its liquid form enters into the formation of the oxychloride of zinc filling cement.

Arseni Trioxidum.—White Arsenic.—*Arsenous Acid* [As_2O_3]. Average dose, gr. $\frac{1}{30}$ (0.002 gm.).

Following the U. S. P. description, arsenic is a heavy solid, occurring "either as an opaque white powder, or in irregular masses of two varieties: one amorphous, transparent and colorless, like glass; the other crystalline, opaque and white, resembling porcelain. Contact with moist air gradually changes the glassy into the white, opaque variety. Both are odorless and tasteless."*

"In cold water both varieties dissolve very slowly, the glassy variety requiring about 30, the porcelain-like about 100 parts of water at 25° C. (77° F.). Both are slowly but completely soluble in 15 parts of boiling water. In alcohol, arsenic trioxide is sparingly soluble, but it is soluble in about 5 parts of glycerin." An aqueous solution is only *faintly acid* in reaction.

Wherever the term "arsenic" is used in the following pages it stands for the official arsenic trioxide. The characteristic action of the drug is due to the ion of arsenous acid and not to the element arsenic, which is insoluble in water.

(The relations of the drug as a caustic only will be treated at this place. For its internal uses, see under Alteratives.)

Arsenic stands alone in its characteristics as an escharotic. The dry powder may be placed on the tongue and allowed to remain for one minute without causing the slightest irritation and, if then thoroughly removed, without producing any effect upon the tissues. On the contrary, if it is allowed to remain until it becomes dissolved and penetrates the tissues, extensive sloughing will result. It cannot be called an irritant. It is not a corrosive. It has no decided chemical affinities; therefore, it is not escharotic by reason of any apparent chemical action.

* United States Pharmacopœia, eighth revision.

It stands by itself as a *vital* or *alterative escharotic,* in that it acts only after being absorbed by the tissue elements, altering or destroying their vital processes in an obscure manner. Because of this action it is difficult, if not impossible, to limit or antagonize its influence upon the tissues which it has penetrated; and its penetration is not limited by any action of its own. The fact of its being tasteless and non-irritating at first, renders its use about the mouth the more dangerous, for by careless handling it may become lodged about the teeth or beneath the edges of the gum, and its presence be not appreciated for hours, until devitalization of the tissue has begun. It does *not coagulate* albumin.

The drug acts slowly, penetrates deeply, and destroys tissue extensively. It seems to affect abnormal or unorganized tissue elements, as in cancer, more readily than normal tissue; hence its use in the removal of abnormal growths. As an escharotic it is always used in its pure form, although often mixed with other agents for convenience of application or to mitigate its action.

The medicinal solutions officially prepared from it are all for internal use, to secure the general tonic and alterative effects of the drug. Therfore, when we speak of applying arsenic locally we mean always arsenic trioxide in powder form or in mixture. (See Alteratives.)

Dental Use.—It is rare that arsenic is used in the mouth for any other purpose than devitalizing pulps of teeth; and it may be said today, after more than half a century of experience with it and with other less dangerous but less efficient devitalizants, that it is the substance of first choice for this purpose. It is only with deciduous teeth that a less powerful agent must be chosen. Here the danger would be penetration of the arsenic through and beyond the apex of the root, with a corresponding extension of its destructive action.

With the exception noted, it is true generally that nothing need be feared, in the way of extension of its action, when the drug is carefully used upon the tooth pulp. The natural confines of the pulp cavity and root canal prevent its penetration to other tissues, so that only careless handling and inappropriate or excessive use need be followed by bad results. While we must admit the possibility of irritation extending beyond the pulp chamber in case of a good-sized apical foramen, a septic inflammation could not be expected from the action of the arsenic, itself being a strong antiseptic.

Careful use of the drug implies (1) isolation of the tooth to be treated, by applying the rubber dam; (2) the use of a small amount of the drug;

(3) careful sealing-in during the period of its action; and (4) its thorough removal after devitalization is complete.

Hofheinz formulates the following rules for the application of arsenic to a pulp:

1. Do not combine it with an escharotic.
2. Never use it in deciduous teeth.
3. Do not place it over an aching pulp.
4. Place it directly on the pulp.
5. Exert no pressure upon the pulp.
6. Never crowd it into root canals.
7. Take special care of the gum tissues if the cavity is near the gingival line.
8. Let it remain twenty-four hours at least.

With the small amount necessary to destroy a pulp, systemic effects will never occur. The ordinary medicinal dose of arsenic is from $\frac{1}{60}$ to $\frac{1}{10}$ of a grain, which need never be exceeded for this use; according to Miller from $\frac{1}{100}$ to $\frac{1}{25}$ is sufficient. It should be impressed upon the mind of the practitioner that any untoward effects that may follow his employment of arsenic in a tooth will be purely local and the result of either want of care in its application or lack of judgment as to its appropriateness.

The precise mode of action of this drug as an escharotic cannot be stated with positiveness. The several views advanced merit our attention, but discussion of them to a definite conclusion is hardly possible.

Sollmann* regards paralysis of the capillaries as the beginning of its action, which, with increased permeability of their walls, is followed by exudation into the connective tissue. These changes, it is observed, are very similar to those of inflammation. Fatty degeneration of cells results and the destruction of tissue is accomplished without evident chemical reactions. This author finds support to the theory of capillary paralysis in the fact that intravenous injections of large quantities of salt solution will cause edema in animals poisoned with arsenic, but not in normal. He suggests further that the distention of capillaries may lead to their rupture and the formation of ecchymoses. (It would seem that such changes must take place in the walls of the digestive tract in arsenical poisoning, for the symptoms and the appearance of the discharges are almost identical with those of cholera, and the destruction of tissue found after death is regarded as due to degeneration

* Sollmann's Pharmacology, 1901.

and not to any direct action of the poison.) Regarding changes in the blood opinions differ, but Silberman* asserts that arsenic tends to cause intravascular coagulation, and the experiments of Heinz† indicate that this is not ordinary coagulation, but formation of thrombi of blood plates, and he attributes the hemorrhages to such thrombosis.

A theory of the action of arsenic advanced by Binz and Schultz‡ is to the effect that arsenous acid is oxidized to arsenic acid by living tissue and the arsenic acid is again reduced to arsenous. This alternate withdrawal and supply of oxygen, in its influence upon the protoplasm, is supposed by them to be the essential feature of the action of arsenic.

Arsenic will attack any soft tissue to which it is applied, so that, when explaining its action, we must recognize its influence upon the vitality of tissue apart from kind or location; but within the pulp cavity and upon so vascular and highly sensitive an organ, enclosed as it is by bony walls with very small unyielding openings for vessels and nerves, the factors of increased pressure, due to the intense hyperemia, and leading to stoppage of the circulation by strangulation of vessels or by thrombosis, is believed to contribute largely to the destructive action.

The occurrence of pain in connection with pulp devitalization depends somewhat upon the condition of the pulp. A healthy pulp, that has not become irritated, may be destroyed without any pain; but in the average case where irritation has occurred, it must be expected that within a varying period of time after the application, usually several hours, the patient will experience pain, first gnawing, later throbbing in character, which will continue until the pulp is destroyed, which is accomplished in from six to forty-eight hours, as a rule.

Combinations.—In its use as a devitalizer, arsenic is combined with other substances to meet two objects—to obtain a convenient form for application and to lessen the pain of its action. The form mostly preferred is that of a paste, which is prepared by rubbing up the powdered arsenic with a sufficient quantity of a volatile oil, creosote, glycerin or carbolic acid. The antiseptic character of these drugs may be held by some to give added value, but arsenic itself is a sufficient antiseptic as to really need no addition on that score.§ It should be noted that any

* Cushny's Pharmacology, third edition, p. 615.

† Ibid. ‡ Ibid., p. 619.

§ According to Koch's experiments (Brunton's Pharmacology, 1885, p. 98), arsenic is one-tenth as strong as bichloride of mercury in antiseptic power. Cushny (Pharmacology, third edition, p. 619) states that it is less poisonous to fungi than to higher forms of life, and that it seems to have no effect upon the action of pepsin and similar ferments.

strong coagulant, such as carbolic acid, by coagulating the surface of the pulp where the application is made, will tend to hinder penetration of the arsenic, on which account it is inferior to a volatile oil. Sometimes cotton fiber is incorporated with the paste, and being then dried, is known as "devitalizing fiber."*

To lessen the pain of devitalization a number of drugs have been recommended and used, but the list can now be narrowed down practically to one, or substitutes for it. Cocaine hydrochloride possesses every quality that is essential, with no serious disadvantage. It is soluble, it mixes with the substances usually combined in the paste, and it is more efficient than any other known agent. The danger of absorption into the general circulation, with the small quantity employed and the barrier presented to its penetration, is so slight that it may usually be disregarded. Any quantity not exceeding one-quarter of a grain may be regarded as safe to use. Proper substitutes for this drug are eucaine, novocaine and orthoform, any one of which may be employed, but they are not more efficient than cocaine. Their chief advantage is in being less toxic, although it may be found by experience with orthoform that its influence is more prolonged because of its insolubility.

In considering this part of the subject it should be remembered that pain in a tooth pulp can be practically relieved at two points—either at the pulp, by agents that paralyze the terminals of the sensory nerve, or at the centers of appreciation of painful sensation in the brain, by agents that depress or benumb those centers. Corresponding in their site of action to these two points, we have two classes of anodynes—those that act locally upon the periphery of nerves, and those that act

* The following formulas of arsenical pastes are typical and useful:

	Gm.	
℞—Arseni trioxidi	2	(gr. 30).
Novocaine	1|30	(gr. 22).
Olei carophylli q. s., to make a paste.		

Coloring matter may be added, if desired to make it contrast to the tooth substance.

	Gm.	
℞—Arseni trioxidi,		
Cocainæ hydrochloridi . . . . . āā	1|30	(gr. 22).
Mentholis	|30	(gr. 5).
Glycerini q. s., to make a paste.		(Kirk).

	Gm.	
℞—Arseni trioxidi,		
Cocainæ hydrochloridi . . . . . āā	1|30	(gr. 22)
Olei caryophylli q. s., to make a paste.		(Miller).

centrally upon the centers for painful sensation. Agents that act locally as anodynes have little or no central effect in ordinary doses, and, conversely, agents that relieve pain by depressing brain centers may have no effect of this kind when applied locally. This line of discussion is prompted by the fact that morphine is so commonly recommended as a local anodyne combined with arsenic. This is entirely opposed to our knowledge of the action of morphine. This drug has almost no local action when applied to sensory nerve endings, but is anodyne only through its central action, after being absorbed into the blood in sufficient quantity. Morphine locally applied, therefore, can be of little use for the purpose of mitigating the pain or irritation caused by arsenic. This fact was recognized many years ago* and is fully supported by the most recent authorities.† The volatile oils, thymol, iodoform and carbolic acid are all feebly analgesic, but inferior to cocaine, while iodoform has the disadvantage of disagreeable odor, and carbolic acid is a coagulant.

Local Poisoning by Arsenic.—The lodgment of arsenic between the teeth or beneath the edge of the gum will cause, after some hours, local irritation leading to engorgement of the gum, which will be followed by sloughing if the poisoning is severe. Pain may be absent. These symptoms will correspond in extent to the depth of penetration of the arsenic, sometimes including pericementum and alveolus. All tissues whose vitality has been seriously disturbed must be expected to slough away.

Treatment of this condition will include the removal, by cutting or scraping, of all tissue that has been destroyed, the scarification of engorged tissue to secure free bleeding, and washing away of any particles of the drug that may remain undissolved, by injecting a stream of water between tooth and gum. Following this, gentle massage of the gums of the whole region will be useful. As a rule, when the patient

* Harris's Principles and Practice of Dentistry, tenth edition, 1876, page 371. "Morphine was formerly supposed to modify the irritating action of arsenous acid, but since this has been discovered not to be the case, its use has been dispensed with by many."

† Cushny, Pharmacology and Therapeutics, 1901, page 208. "It is often stated that the sensory terminations are paralyzed by morphine, and solutions are therefore injected into the seat of pain, or liniments are rubbed into the skin over it, but as a matter of fact, morphine seems entirely devoid of any such local action."

Sollmann, Pharmacology, 1901, page 204. "Particular stress must be laid on the fact that the *sensory endings are in no way affected*, so that the local application of morphine or opium is entirely irrational."

presents with these symptoms the damage will have been done, and local medication is of doubtful value. But if any arsenic still remains about the tissues, the freshly prepared ferric hydroxide will neutralize it wherever accessible. The latter may be packed about the teeth and beneath the gum margin. Dialyzed iron has been recommended, but it is inferior to fresh ferric hydroxide (see below). Tincture of iodine is believed by some to be a useful application, and the same may be said of tincture of chloride of iron, but neither of these exert any antidotal action except as they stimulate the tissues to better resistance. Scarification will usually precede the use of any of these agents.

General Poisoning by Arsenic.*—Acute general poisoning occurs as the result of an overdose being taken into the stomach. Usually the symptoms develop slowly, beginning with gastrointestinal irritation. There is in most cases sufficient time to administer an antidote and empty the stomach if the mistake of dosage is discovered at once. An ordinary emetic is to be given at once (one to three teaspoonfuls of mustard flour in a glass of lukewarm or cold water, or the same quantity of either powdered alum or common salt with a little water, or one-third of a teaspoonful of sulphate of zinc); meantime the antidote should be prepared and given.

The best antidote to arsenic is *ferric hydroxide*, which is prepared by adding an alkali to a solution of a ferric salt, which precipitates the brown ferric hydroxide. It must be freshly prepared. This is easily done by mixing *milk of magnesia* (Magma Magnesiæ, U.S.P.) with *tincture of chloride of iron* or with *Monsel's solution*, both agents to be diluted somewhat before mixing. It should be taken freely immediately after being mixed, as it gelatinizes upon standing. The official dose is f℥4 (120 mils). (See also Table of Poisons and Antidotes.)

Cobalt (not official).—While pure cobalt [Co] is a distinct chemical element, in the commercial form arsenic is associated with it. It is employed to devitalize pulps, and in this use it acts very much like diluted arsenic, being slower in action and less irritating than pure arsenic, and, in some cases, even painless.

* The fact may be stated that in some parts of the world, especially in Styria, the peasants take arsenic habitually and acquire a tolerance to the drug, so that they take quantities which would ordinarily be poisonous. It is claimed that it secures a ruddy complexion and plumpness of form, as its action favors the deposit of fat in the tissues, and that mountain climbing is easier under its use, requiring less effort and producing less respiratory discomfort.

Actual Cautery.—This term applies to the use of heat of sufficient degree to burn the tissue. Formerly an iron or silver wire was employed, heated to a white heat. Pulps were destroyed by plunging the heated wire directly into the pulp canal. Fortunately both the means and its use have become obsolete. Nevertheless heated metallic points and wire loops are frequently employed in general and special surgery today. The approved methods of applying the actual cautery are the following:

Thermocautery.—Under this term there is arranged an apparatus, by means of which a platinum point, previously heated up in a gas or spirit flame, is maintained continuously at a white or red heat by the combustion of gasoline vapor forced through it. Paquelin's thermocautery is the one mostly used. Platinum points of various sizes and shapes permit an extensive use of this method for removal of small tumors, checking hemorrhage, etc. It is seldom used about the mouth, preference being given to the galvanocautery.

Galvanocautery.—This consists of a galvanic battery, arranged in simple circuit—*i. e.*, with all positive elements connected together and likewise all negative, so as to equal in effect one large cell. A battery so arranged presents a large surface of elements with the resistance of only one cell. It furnishes a large *quantity* of electricity capable of producing a high degree of heat when it meets with external resistance. Platinum loops in various shapes and sizes, adapted to cutting, searing or snaring tissue, are employed. One of these mounted upon a suitable hand-piece and included in the current furnishes a sufficient resistance to convert the electricity into heat, the degree of which can be easily regulated by manipulation of the battery.

A great advantage attaching to this method, for use about the face and mouth, is that the patient need not see the heated loop. It may be placed right in proximity to the diseased or bleeding tissue before the current is turned on; and if the application of cocaine precedes its use the pain is not severe.

CHAPTER VIII.

DEMULCENTS AND EMOLLIENTS.

DEMULCENTS.

Demulcents are agents that protect or soothe raw, irritated or inflamed surfaces. They consist chiefly of oily, mucilaginous or albuminous substances, of which the ones here named are the most important:

Oleum olivæ (*olive oil*).
Oleum lini (*linseed oil*).
Oleum gossypii seminis (*cottonseed oil*).
Petrolatum liquidum (*albolene*).
Acacia (*gum arabic*).
Linum (*flaxseed*).
Ulmus (*slippery elm bark*).
Albumin.

The oils are used in their ordinary form, as a rule; sometimes, however, the addition of an alkali is advisable, and such a combination is found in the time-honored "carron oil," known officially as linimentum calcis.* This has long been a favorite application to burns and scalds. A disadvantage in its use lies in the fact that linseed oil dries upon exposure, and the stiffening of the dressing which results may make it more difficult to remove. This may be obviated by substituting cottonseed oil for linseed oil in the combination.

In poisoning by corrosives and irritants, demulcents are valuable to protect the injured surfaces. Any of the above are applicable, except that in poisoning by phosphorus or cantharides oils should not be used, as they are solvents for these drugs. In any case where albumin is the proper antidote it may be the demulcent of choice so as to serve a double purpose, raw egg being the best form.

The mucilaginous drugs are employed in aqueous solution, either infusion, mucilage or syrup, and are for internal use, being seldom applied externally except in poultices. When flaxseed tea is to be prepared, the whole seed, not ground, should be treated with hot water. The mucilage is present in the shell and is thus easily dissolved out. The ground seed is used only in poultices.

	Gm. or mil.	
*℞—Olei lini	60	(f℥ij)
Liquoris calcis	60	(f℥ij)—M.

Sig.—Apply freely and cover with dressing.

Certain sialagogues and expectorants may exert a secondary demulcent effect through stimulating secretion in the irritated or inflamed part. Irritation of the air passages, and particularly an irritative cough, is often due to dryness of the mucous membrane. Sialagogues or expectorants may be the very best agents to relieve this irritation by increasing secretion, which moistens the irritated surface, and at the same time the engorgement of the tissue is lessened. The drugs mostly used in this way are:

Cubeba (*cubeb berries*).
Glycyrrhiza (*licorice root*).
Ipecacuanha.
Ammonii chloridum.

EMOLLIENTS.

Emollients are agents that soften and soothe an inflamed part. Fatty preparations, in the form of ointments, are used to soften the skin and at the same time protect denuded or ulcerated surfaces from dust and from the drying effect of the air. Among the fats, lanolin (adeps lanæ), the fat of sheep's wool, deserves special mention as a valuable emollient. Its penetrating and softening power, it is claimed, exceeds that possessed by any other fat; and it has the unique property of mixing with at least 30 per cent. of its own weight of water without losing its ointment-like character. The latter quality permits the use of solutions of salts or alkaloids in an ointment, which is often desirable, as in case of a painful sore. Here a crystalline substance like cocaine should be more active when in solution and mixed with lanolin, than when the particles are simply rubbed up with a fat that has feeble penetrating power.

Where protection by a fat is the chief purpose, lard (adeps) and vaseline (petrolatum) are the most commonly employed bases for ointments, but in softening and penetrating power they seem to be inferior to lanolin. Lard, being an animal fat, is better in this respect than vaseline, which is not a true fat, but a product obtained in the distillation of petroleum.

The poultice (cataplasm) is another form of emollient application. Various substances may enter into the composition of poultices, but the possibilities of their use are most typically combined in ground flaxseed. The shell of this seed contains 15 per cent. of mucilage and the interior contains 25 to 40 per cent. of oil. By treating the ground seeds with hot water we obtain a poultice having the emollient qualities of both oil and mucilage. Applied hot the relaxing effect of the heat contributes to the softening process, and altogether we have in the poultice a great aid in either resolving an inflammation, or hastening suppuration when it cannot be prevented.

Glycerinum.—Glycerin.—Glycerol. This substance is obtained by decomposition of oils and fats, being a by-product in the manufacture of soaps, and it should contain not less than 95 per cent. of absolute glycerol [$C_3H_5(OH)_3$], a trihydric alcohol.

It is a thick, heavy, colorless liquid, *neutral*, freely soluble in water, in alcohol and in a mixture of 1 part ether and 3 parts alcohol, but insoluble in ether, chloroform and oils. Its specific gravity is about 1.250. It has a sweet taste, and when applied to a mucous surface produces a warm or burning sensation. It does *not coagulate* albumin. The chief quality that determines its action upon tissue is its marked affinity for water, it being capable of absorbing 50 per cent. of its own weight; therefore, when applied to a raw surface glycerin may irritate by its energetic abstraction of water, but it does not irritate the unbroken skin or mucous membrane. Its effect upon tissue is to soften and protect.

As an emollient, glycerin is used extensively in hand lotions and either in full strength or diluted with an equal quantity of water, as a simple application to chapped hands. Here its action is typically seen. The smarting at first experienced is due to its abstraction of water from the tissues wherever the skin is cracked or broken. This is succeeded by a softness of the skin, due to the increased amount of moisture which is attracted into the superficial layers of epithelium by the action of the glycerin. When we observe that chapping of the hands occurs mostly in cold weather, when the absolute moisture of the atmosphere is greatly reduced by precipitation, we can appreciate the importance, as a causative factor, of excessive drying of the skin by the surrounding air; and we are helped to an understanding of the value of glycerin as a retainer of moisture wherever applied to soft tissues. The maintenance of a normal degree of moisture is, of course, essential to the healing of wounds of the skin.

Roughness of the hands, or of the skin of other parts, is effectually treated by a lotion of glycerin and water, or glycerin, water and alcohol. If there is a tendency to scaling of the epithelium, or increase of sebaceous secretion, as in "dandruff" of the scalp, the addition of salicylic acid is very useful. The following formula is suggested:

	Gm. or mil.		
℞—Acidi salicylici	1		(gr. xv)
Alcoholis	30		(f℥j)
Glycerini	30		(f℥j)
Olei amygdalæ amaræ		30	(♏v)
Aquæ q. s. ad	90		ad (f℥iij).—M.

Sig.—Hand lotion.

Glycerin keeps indefinitely and is even classed among the antiseptics. It is an excellent preservative. It is used also as a solvent and vehicle for other drugs, and is often incorporated in small amount with extracts in order to keep them from becoming dry.

Its combination with tannic acid, known as glycerite of tannic acid,* is a powerful astringent. In dentistry it is used in case of hyperemia of the pulp previous to capping; also after the application of arsenic to a pulp, it may be employed to harden or tan the pulp tissue in order to facilitate its removal. It is a generally useful astringent to mucous membranes.

Incompatibility.—With *borax* a solution is formed which becomes acid in reaction, but whose value is not otherwise lessened. Glycerin should never be combined with *nitric* and *sulphuric acids,* nor with *chromic acid, chlorinated lime* or *potassium permanganate,* for fear of explosive results.

* The official *Glyceritum acidi tannici* has the following formula:

	Gm. or C.c.
℞—Acidi tannici	20
Glycerini	80

M.—Heat mixture until complete solution occurs.

CHAPTER IX.

ASTRINGENTS AND HEMOSTATICS.

Astringents are agents that cause contraction of tissue. In a general view of the use of astringents, we include the checking of hemorrhage and of diarrhea and the lessening of inflammation, particularly of the mucous surfaces.

The several modes of action of astringents may be stated to be:

1. Simple contraction of the tissues of the part, as by cold applications.

2. Coagulation of the surface, as by tannic acid.

3. Constriction of arterioles, thus lessening the blood supply to the tissues, as by application of suprarenal gland products.*

4. Abstraction of water from the tissues, as by alcohol locally applied.

The terms *hemostatic* and *styptic* apply to agents that arrest hemorrhage. Most of these act by securing coagulation of the blood, but some act mechanically, such as ligatures and bandages, and others lessen the blood supply to the bleeding part, as cold and arterial sedatives. Other styptics induce contraction of the arterioles; ergot, antipyrine, suprarenal gland and the local application of hot water, all act in this way, ergot acting through the system, while the others act by local application. Collodion exerts pressure through contraction of its volume while drying.

It must be borne in mind that the *one object* of employing any hemostatic is to secure *coagulation of blood* at the point of hemorrhage; and the employment of the various agents can only facilitate this process; so that the use of coagulating agents, the lessening of the amount of blood in the part, the contraction of arterioles, and the employment of pressure, all have precisely the same object, but secure it in different ways. The choice of agent depends upon locality and size of the vessels that are injured.

A capillary hemorrhage can usually be controlled by coagulants, or by cold, or by agents like antipyrine, which causes the arterioles to contract. If the hemorrhage is from a larger vessel, or from a tooth socket, where the muscular control of the capillary circulation is deficient, pressure upon the bleeding points, or, in extreme cases, ligation of the

* The U. S. Pharmacopœia gives epinephrine as the active principle of the suprarenal glands. This, or similar body, is known commercially as adrenalin, aduephrin and suprarenin.

vessel, may be required. Again, in case of hemorrhage from the bowel or lung, perfect rest of body and mind, the ice-water coil and arterial sedatives will be employed. But with all our art we are only aiding nature to secure coagulation.

The following classification will aid our consideration of these agents:

CLASSIFICATION OF HEMOSTATICS.

COAGULANT ASTRINGENTS.
1. *Vegetable.*
    Tannic acid.
    Drugs containing tannic acid:

Nutgall.	Hematoxylon.
Gambir (catechu).	Hamamelis.
Kino.	Tea.
Krameria.	Coffee.

    Alcohol.
2. *Mineral.*
    Iron preparations:
        Tincture of ferric chloride.
        Solution of ferric chloride.
        Ferrous sulphate.
        Ferric subsulphas (Monsel's salt).
        Solution of ferric subsulphate.
    Alum.
    Copper sulphate.
    Lead acetate.
    Silver nitrate.*
    Zinc chloride.*
    Zinc sulphate.

VASCULAR ASTRINGENTS.
1. *Those that act locally:*
    Antipyrine.
    Epinephrine.
    Heat.
2. *Those that act after absorption into the general circulation:*
    Ergot.
    Gallic acid.

REMEDIES THAT FAVOR COAGULATION OF THE BLOOD.
1. *By reducing blood-pressure:*
    Cold.
    Arterial sedatives:
        Aconite.
        Veratrum viride.
2. *By acting in the blood to increase its coagulant property:*
    Calcium salts.
    Thyroid preparations.
    Blood serum.
3. *By causing direct pressure or occlusion of vessels:*
    Collodion.
    Bandages, ligatures and other surgical measures.

* Caustic in full strength.

Application of Cold.—By this is meant not only the abstraction of heat, which may be desirable, but also the contact of a substance having a low temperature with the skin, in order to cause a reflex contraction of the muscularis of the skin and of the arterioles.

The ice-bag, ice-water, or ice directly applied, are the usual means. If considerable surface is to be treated, a very convenient method of applying ice-water continuously is by means of the Leiter coil, which consists of soft-rubber tubing coiled concentrically to fit upon the part (as in form of skullcap for the head), or wound about an affected joint; through the tubing ice-water is run by siphonage as constantly as may be desired. Cold applications will be found useful to lessen the hyperemia of acute inflammation and to lessen the amount of blood in the locality of a hemorrhage. The twofold action induced is reduction of blood supply and condensation of tissue. In employing cold locally to relieve toothache we secure its astringent action upon the local circulation, and we also have the sedative effect of the cold upon the nerve endings. A pulpitis may sometimes be relieved by the contact of ice with the tooth and contiguous tissues.

Application of Heat.—Practically the only uses of heat as a hemostatic are two—(1) as hot water applied to a surface where there is oozing from small vessels, the heat causing vascular constriction through irritation; and (2) as some form of actual cautery, by which the bleeding point is seared.

Coagulant Astringents (Vegetable).

Tannic acid is the astringent principle in each drug of the vegetable group, therefore a discussion of its action and uses will suffice for all.

Acidum Tannicum.—Tannic Acid.—*Tannin* [$HC_{14}H_9O_9$].—An organic acid obtained usually from nutgall. Average dose gr. 8 (0.5 gm.). It is a yellowish powder, becoming darker upon exposure; soluble in less than 1 part of either water or alcohol, and in about 1 part glycerin with the aid of moderate heat. These solutions have an *acid* reaction.

Its chief action is that of a *coagulant*. It has a bitterish and astringent taste, but is non-irritating to the tissues. It is useful only when applied locally to tissues, as it has no effect through the circulation; in fact, tannic acid is never absorbed into the circulation. When taken into the stomach it unites with any albuminous matter present, it interferes with the activity of pepsin, and, if in excess, some may be converted into gallic acid, which can be taken up into the system.

The drug may be applied in powder to a bleeding-point, or packed with cotton into a tooth socket. In any strength of solution it may be applied to inflamed, raw or ulcerated mucous surfaces, or used as a gargle.

In catarrhal and relaxed states of the mucous membrane it is a useful application, especially when combined with glycerin. Being incompatible with alkaloids, it is used as a chemical antidote to them. In hemorrhage from the stomach it is taken in strong solution or powder form, but for internal hemorrhages outside of the digestive tract it is of no value, except as it is changed into gallic acid, which may be absorbed and possibly exert some general influence.

Tannic Acid Group or Vegetable Astringents.—All vegetable astringents owe their activity to the tannic acid which they contain, so it is a matter of personal choice whether the pure acid or a drug containing it be used. For hemostatic purposes preparations of astringent drugs are rather weak, but for a mouth wash or gargle they are useful.

Incompatibility.—Tannic acid drugs are incompatible with *albumin, alkaloids, ferric salts, lime-water, mineral acids* and most *metallic salts.*

Galla.—NUTGALL.—An excrescence occurring on certain species of oak, caused by the puncture and deposit of ova of an insect This is the source of the official tannic acid. Average dose gr. 8 (0.5 gm.), but the drug is seldom used except externally in the form of tincture or ointment.

Gambir.—CATECHU.—An extract prepared from leaves and twigs of *Ourouparia gambir.* The compound tincture and troches are used.

Kino.—The dried juice of *Pterocarpus marsupium,* average dose gr. 8 (0.5 gm.). The tincture is the only official preparation, average dose ♏ 60 (4 mils).

Krameria.—RHATANY (not official).—The root of several species of Krameria. This drug has a number of preparations.

Hematoxylon.—LOGWOOD (not official).—The heart-wood of *Hæmatoxylon campechianum.* Besides tannin, this drug contains hematoxylin, which is used to stain microscopic specimens. The extract may be used.

Hamamelis.—WITCH-HAZEL (not official).—The leaves and bark of *Hamamelis virginiana* collected in autumn. The fluidextract is used.

Tea and Coffee.—Although not official, tea leaves and coffee seeds contain a variable amount of tannic acid, tea yielding about 15 per cent. and coffee somewhat less.

While all tannins are similar, some may be distinguished by their

reaction with ferric salts, *e. g.*, gallotannic acid will yield a bluish-black and kinotannic acid a greenish-black ink.

Drugs of this group are non-poisonous. Their preparations may be used freely as astringents either in full strength or diluted with water.

Alcohol.—RECTIFIED SPIRIT.—*Ethyl Alcohol* [C_2H_5OH]. A liquid composed of about 95 per cent. by volume (92.3 per cent. by weight) of ethyl alcohol and about 5 per cent. by volume (7.7 per cent. by weight) of water. Sp. gr. about 0.816 at 60° F. It is obtained by fermentation of grain or the juices of fruits, and subsequent distillation. It is a clear, colorless, volatile liquid, with a burning taste and a distinctive odor. Alcohol boils at 172.4° F.

This agent is *neutral*. It has a great affinity for water, even absorbing it from the atmosphere, and it *coagulates* albumin. It burns with a blue, smokeless flame, yielding a high degree of heat, which renders it very useful in the spirit lamp. In addition it is extensively used as solvent, preservative and drying agent.

The following strengths of alcohol also are official, but whisky and brandy (about 50 per cent.) and wines (8 to 20 per cent.) have been dismissed from the *Pharmacopœia*.

Alcohol Dehydratum (not less than 99 per cent. by weight) is the purest spirit obtainable. Owing to the strong affinity which alcohol has for water, it is impossible to separate them absolutely; but, by treating strong alcohol with potassium carbonate and fused calcium chloride, which have a stronger affinity for water, and redistilling, all except a fraction of 1 per cent. of water can be removed. Absolute alcohol is equally difficult to keep in full strength on account of absorption of moisture from the air. It must be kept in well-stoppered bottles and exposure to air avoided. It is highly inflammable. It is seldom that so strong a spirit is needed, but it may be required for special uses as a solvent and as a chemical.

Alcohol Dilutum (about 49 per cent. by volume). This, composed approximately of equal parts of alcohol and water, corresponds nearly to "proof spirit" (50 per cent.), which is the United States standard for measuring unrectified spirit.

Spiritus Frumenti (whisky) contains from 44 to 55 per cent. by volume of alcohol. It is distilled from fermented grain and should be at least four years old. (Not official.)

Spiritus Vini Gallici (brandy) contains from 46 to 55 per cent. by volume of alcohol. It is distilled from the fermented juice of grapes and should be at least four years old. (Not official.)

Whisky and brandy do not gain in alcoholic strength by age, but they develop flavor; and, in whisky particularly, the fusel oil, which is a natural impurity of raw spirit, is destroyed during the ripening process.

Local Action and Uses of Alcohol.—This drug is astringent by virtue of its power to coagulate albumin and to abstract water from the tissues. The coagulum is not so firm as that produced by most mineral astringents, and it may be gradually redissolved by the alkaline fluids of the tissues. When applied in the full strength to the mucous membrane, alcohol induces first a burning sensation, which becomes painful as the full action upon the tissue is attained. With its evaporation a cooling sensation may then be experienced. The irritation soon passes away, and there remains a sense of fulness in the part, with corrugation of the surface, which at the same time has acquired a whitish appearance in the superficial layer. Gradually the mucous membrane will be restored to its normal condition with very slight surface exfoliation. The action is very superficial and of only moderate duration. Alcohol, therefore, cannot rank as more than a mild astringent, but the possession of the power to abstract water, with its volatility, makes it a valuable drying agent wherever applied. Added its antiseptic quality, we have in alcohol an agent that is cooling to an inflamed surface, slightly astringent and antiseptic—the very qualities that make it (whether used pure, diluted, or as a vehicle for other substances) a very useful wash or application in stomatitis or any unhealthy state of the gum or mucous membrane. The strength as a mouth wash should not exceed 1 part alcohol to 2 parts water.

It is also useful as a drying agent in cavities and root canals; and if its application be followed by that of chloroform or ether a mos perfect and rapid removal of moisture will be effected; the alcohol first taking up the moisture, evaporation is then hastened by the alcohol being taken up by the more rapidly volatile chloroform or ether. The only precaution necessary regarding this use is the avoidance of the proximity of a flame, because of the inflammability of alcohol and of ether.

Alcohol is also a useful lotion when applied, somewhat diluted, to a bruised or inflamed surface; and if capillary oozing be present, its action will favor coagulation of blood and contraction of arterioles.

It must be said that alcohol contributes much to the local action of certain tinctures, of which tincture of myrrh is an example; indeed, in this preparation the alcohol is much more important and active than is the myrrh. (See under Antiseptics.)

Applied to the skin, the action of alcohol is less marked than upon mucous membranes, because of the firmer texture of the former and the better protection it affords to the sensitive structures beneath. Rubbing or bathing the skin with alcohol produces, first, cooling of the surface, which is soon followed by a reaction that is delightful.

The power of attracting moisture gives alcohol a place as a remedy in carbolic acid poisoning. Its action here is more upon the injured tissue than upon the poison. (See Phenol Poisoning.) The same property, plus antiseptic power, makes alcohol a detergent of some value.

In addition to remedial uses, alcohol is employed largely as a solvent for drugs, being the chief menstruum in fluidextracts, tinctures, spirits and elixirs, besides being used to extract many vegetable active principles. When selecting an astringent drug for use, it follows that the *tincture* of that drug (if its solution in alcohol is possible) will be especially efficient by reason of the added action of alcohol.

Alcohol is also used as the general solvent for resins, as in the preparation of sandarach varnish.

The internal action of alcohol is considered under Stimulants.

Incompatibility.—Alcohol is incompatible with *albuminous substances,* all of which are coagulated by strong alcohol. It precipitates *gums* from their aqueous solutions. On account of their insolubility in alcohol many *salts* of the alkalies and metals may be precipitated by it from their aqueous solutions. Both *chromic acid* and *potassium permanganate* are decomposed by alcohol.

Methyl Alcohol (not official).—Wood Spirit [CH_4O]. A thin colorless liquid obtained in the destructive distillation of wood. It has a peculiar odor and burning taste, sp. gr. about 0.800, and boils at about 151° F. It burns with a pale, smokeless flame, giving less heat than ethyl alcohol. By partial oxidation it yields formaldehyde gas. A purified product is called *Columbian Spirit.* Wood spirit is used as a substitute for ethyl alcohol as solvent and for external uses. Its use as a solvent may be proper, but on account of its poisonous action it should never be used in medicine. Aside from deaths caused by methyl alcohol, many cases have been reported within recent years where blindness, more or less permanent, followed contact with the fumes of this drug.

Coagulant Astringents (Mineral).

This group of drugs stands in contrast with the tannic acid group, as we might expect from their compound chemical nature. They are

compounds of acids with metallic bases, so that, by their dissociation in contact with tissues, we have two distinct agents concerned in the action of each mineral astringent. This fact is given prominence by some of the later authorities in pharmacology* and its recognition removes much of the difficulty in understanding the action of these salts upon living tissues. The essentials of their action may be stated as follows: Mineral astringents have the property of precipitating albuminous or proteid substances. This must be understood to be a definite chemical reaction, whereby a metallic albuminate is formed and the acid of the salt is liberated. There is, therefore, added to the coagulation or precipitation process the action of whatever acid is liberated. As they differ in coagulant power, the sum of the action of such astringent will depend, as Cushny states,† upon "Two factors—the character of the precipitate and activity of the acid formed. The latter again varying with the extent to which it is dissociated into ions; it, therefore, exercises the same astringent or corrosive effects as if it had been applied uncombined. But its action may be modified by the presence of metallic albuminate protecting the surface." The firmer the coagulum the less will the liberated acid irritate the tissues, and, on the other hand, the stronger the acid liberated the greater will be the possibility of irritation by it. We would, therefore, expect the mineral acid salts to be more irritating than organic acid salts. This we find to be the case in comparing the action of chloride of zinc with that of acetate of lead. Again, among the mineral acid salts those that are most easily dissociated, such as the soluble chlorides and nitrates, are found to be most irritating. A comparison of the chloride and sulphate of zinc gives evidence of this, the chloride being much more irritating. The variety of these mineral compounds permits of the selection of an agent for any grade of action desired.

The group of astringent iron salts in common use comprise the following, all of which are *acid* in reaction:

Ferri Chloridum.—FERRIC CHLORIDE [$FeCl_3 + 6H_2O$]. An orange-yellow, crystalline salt, with a strongly astringent taste. Very deliquescent in moist air and freely soluble in water and in alcohol. It contains not less than 20 per cent. of iron. Used chiefly in the two following preparations:

Tinctura Ferri Chloridi.—TINCTURE OF FERRIC CHLORIDE.—This contains about 5 per cent. of metallic iron. Average dose, ♏ 8 (0.5 mil.). It has a very astringent taste and *acid* reaction.

* See Cushny, Pharmacology and Therapeutics, fifth edition, 628. † Ibid., p. 628.

Liquor Ferri Chloridi.—SOLUTION OF FERRIC CHLORIDE.—This contains about 10 per cent. of metallic iron. Average dose, ♏ $1\frac{1}{2}$ (0.1 mil.). It has a very astringent taste and *acid* reaction.

Ferri Subsulphas (not official).—BASIC FERRIC SULPHATE.—*Monsel's Salt.*—The chemical composition of this salt is variable.

Liquor Ferri Subsulphatis.—SOLUTION OF BASIC FERRIC SULPHATE. *Monsel's Solution.*—This contains 13.5 per cent. of metallic iron.

This preparation is often improperly called *persulphate of iron.* The true persulphate is a normal salt, official in form of its solution (*Liquor Ferri Tersulphatis*) but very seldom used.

Of all of the above, the liquor ferri subsulphatis or Monsel's solution is used more than all others as a hemostatic. It is objectionable on account of the copious, dirty, black coagulum which it produces; and it also stains any fabric that it touches. It is not an agent of first choice, but is used rather as a later resort when the milder astringents have failed. It is very efficient even when largely diluted. As astringents for use in the mouth, the whole group here named are objectionable because of their strongly *acid reaction,* which renders them deleterious to the teeth. If employed at all, strict precaution should be taken to prevent their contact with the teeth, and neutralization of their acidity should follow their use. A solution of sodium bicarbonate is a useful alkali for the latter purpose. *Hemostatic cotton* is prepared by saturating absorbent cotton with either Monsel's solution or solution of ferric chloride and drying.

It should be remembered that not all iron preparations affect the teeth. They all may form iron sulphide in a foul mouth or in a carious cavity, with a resulting stain, but only those that have an *acid reaction* are destructive to the tooth structure. All astringent iron salts are acid, but for internal administration there are a number of neutral preparations that are harmless. (See under Restorative Tonics.)

Incompatibility.—Ferr*ic* salts in solution, with *alkalies* or *alkaline carbonates* in excess, produce a brown precipitate of ferric hydrate. With *tannic acid,* tannate of iron (black ink) is formed.

Ferr*ous* salts with *oxidizing agents* are converted into ferric salts. With *alkalies* and *alkaline carbonates,* solutions of ferrous salts yield precipitates. Tannic acid produces no change in ferrous salts in the absence of oxygen.

Alumen.—ALUM.—*Aluminium and Potassium Sulphate* [$AlK(SO_4)_2 + 12H_2O$], or *Aluminum and Ammonium Sulphate* [$AlNH_4(SO_4)_2 + 12H_2O$]. Either potassium alum or ammonium alum is official under this title.

It occurs in colorless crystals having a sweetish and strongly astringent taste and *acid reaction.* Potassium alum is soluble in 7.2 parts of cold water, 0.3 part of boiling water, freely soluble in glycerin, but insoluble in alcohol. Ammonia alum is somewhat less soluble in water. Alum *coagulates* albumin, acting superficially as an astringent and hemostatic. Average dose, gr. 8 (0.5 gm.). In larger dose the drug is emetic. To check slight hemorrhages the pure crystal or strong solution may be applied. For nosebleed a nasal irrigation or injection of the solution as hot as can be borne is useful. The aqueous solution may be used in any strength as a gargle or wash, but, being *acid* in reaction, it is not admissible as a mouth wash for continuous use.

When alum is subjected to a high degree of heat it loses its water of crystallization and becomes opaque and amorphous. It is then known as dried alum (alumen exsiccatum) or "burnt" alum, and is more energetic in its action upon tissue, being even escharotic to loosely organized tissue.

Incompatibility.—Alumen is incompatible with *alkalies* and their *carbonates.* With *metals* soluble in dilute sulphuric acid the aqueous solution of alum will liberate hydrogen.

Argenti Nitras.—NITRATE OF SILVER [$AgNO_3$]. Average dose, gr. $\frac{1}{6}$ (0.01 gm.). This drug is described and discussed quite fully in the chapter upon Escharotics. As an astringent it is used upon mucous membranes in conditions of relaxation or of chronic catarrh, such as chronic pharyngitis, where the dilated capillaries give evidence of a decided loss of tone in the mucous membrane. The indications here are for a drug that will cause condensation of the relaxed tissue with contraction of the dilated vessels. Nitrate of silver is one of our best agents to accomplish this when applied in solution of from 1 to 5 per cent., the stronger solutions being commonly used with an atomizer. It is irritating, but superficial in its action. It *coagulates* albumin. Its irritant action is explained in part by the liberation of nitric acid at the time of its coagulant action, albumin taking the place of the acid in the combination. In connection with the application of this drug it may be remarked that a catarrhal condition does not need a constant irritant. The restoration of the vascular tone will occur slowly under the influence of a decided local stimulant applied not too frequently. For the best effect, therefore, nitrate of silver should not be applied oftener than once a day or once in two days. In general, any strength of solution may be used up to 5 per cent., although this strength is decidedly irritating. Any excessive action may be prevented by

promptly neutralizing with a solution of sodium chloride. This drug cannot be used in a mouth wash nor upon visible surfaces, because it blackens tissues and fabrics wherever it touches and may stain tooth structure. The solutions of silver nitrate are *neutral*. As a rule it is not prescribed in combination with other substances.

Cupri Sulphas.—SULPHATE OF COPPER.—*Blue Vitriol* [$CuSO_4 + 5H_2O$]. This substance occurs in blue crystals with a metallic, nauseous taste, soluble in 2.5 parts of water, 2.8 parts of glycerin and in 500 parts of alcohol. The solution is *acid* in reaction. It *coagulates* albumin. It ranks with silver nitrate as an irritating astringent, being even a mild caustic when used in the form of crystal or strong solution. The acid liberated in connection with its coagulant action is sulphuric, one of the most irritating of acids. Its value in dental practice is limited, being useful for limited application where a decided, though irritating, astringent effect is desired. If it is allowed to enter a carious tooth staining is likely to result.

Internally the drug is emetic in full dose, the average dose being gr. 4 (0.25 gm.). In case of poisoning by it albumin is the best chemical antidote.

Plumbi Acetas.—ACETATE OF LEAD.—*Sugar of Lead* [$Pb(C_2H_3O_2)_2 + 3H_2O$]. Average dose, gr. 1 (0.06 gm.). (For preparations, see Index of Drugs.)

It occurs in colorless or whitish crystals or masses, having a slight odor and sweetish, astringent taste. It is somewhat efflorescent, absorbing carbon dioxide from the air; soluble in 1.4 parts of water and in 38 parts of alcohol, freely in glycerin. It is *slightly alkaline* in reaction. It *coagulates* albumin, being one of the active mineral astringents. It is classed as a *sedative astringent* because of the absence of any marked irritation from its application. This fact agrees with the explanation that the acid of an astringent salt is liberated at the time of the coagulant action, being displaced by the albumin. In case of this substance acetic acid is liberated, which in its dilute form is not irritating. When used internally this drug presents the danger of lead poisoning. Therefore, its use is somewhat restricted as to quantity and length of time employed. In conditions of denuded surfaces, irritable ulcers, and acute local inflammations of the gums, the solution may be employed, but swallowing the drug must be avoided. On account of this danger the lead preparations are seldom used internally, and even their external application to large surfaces may induce poisoning. For local use a simple solution of the salt in water or alcohol, or the

official solutions of the subacetate may be employed. The latter contain a considerable amount of oxide of lead, which is soluble in a solution of the acetate with a change of the latter to the subacetate. The official diluted solution, known as *lead-water*, is of proper strength for ordinary use; or a stronger application may be obtained by diluting the stronger solution, which is known as *Goulard's extract*. A favorite application with some is the *lead and opium wash*,* but the addition of the tincture of opium can contribute very little to the local action of the combination, except the astringent action of the alcohol it contains, as it is well known that opium has no appreciable local action.

Among the evidences of saturation of the system by lead, there is noticed, especially in foul mouths, a blue line within the gum close to the margin. This is believed to be a deposit of lead sulphide within the tissue, and it is indicative of chronic lead poisoning only. (For symptoms, etc., of acute poisoning, see Table of Poisons and Antidotes.)

Incompatibility.—Acetate of lead is incompatible with most *acids* which displace the acetic acid, with *iodide of potassium* and with *liquor iodi compositus*. The solution of the subacetate will precipitate solutions of *acacia*.

Zinci Chloridum.—CHLORIDE OF ZINC [$ZnCl_2$]. This substance is used more as an escharotic and antiseptic, but in the weaker solutions (1 to 10 per cent.) it is astringent. It *coagulates* albumin, but on account of the hydrochloric acid liberated the application of a strong solution is painful, and it is also quite penetrating. It is *acid* in reaction.

Zinci Sulphas.—SULPHATE OF ZINC.—*White Vitriol* [$ZnSO_4 + 7H_2O$]. Average dose, as emetic, gr. 15 (1 gm.). It occurs in colorless crystals or crystalline powder, having an astringent, metallic taste, soluble in 0.6 part of water and in 2.5 parts of glycerin; insoluble in alcohol. It is *acid* in reaction and it *coagulates* albumin. It is one of the feebler astringents, well adapted to the more sensitive mucous membranes, as the conjunctiva of the eye. In acute conjunctivitis and in acute disease of the antrum, it is a useful astringent in 1 per cent. solution. About the mouth it may be used stronger, as it is not irritating to the oral mucous membrane. It is a reliable emetic frequently employed to empty the stomach in cases of poisoning. In such emergency a dose of 30 grains (2 gm.) may be given.

* Lotio plumbi et opii (N. F.):

		Gm. or mil.		
℞—Plumbi acetatis		17	5	
Tincturæ opii		35		
Aquæ	q. s. ad	1000		—M.

Incompatibility.—Sulphate of zinc is incompatible with *alkalies* and their *carbonates* and with *ammonium sulphide*.

Zinci Iodidum.—Iodide of Zinc [ZnI_2] (not official).—This salt occurs as a white powder, having a sharp taste, very deliquescent, and becoming brown upon exposure from the liberation of iodine. It is freely soluble in water and alcohol, and is *acid* in reaction. Its action is chiefly alterative combined with the characteristic action of the zinc ion. Dr. E. S. Talbot, after considerable experience with it, advises its use in interstitial gingivitis in the following combination with iodine, to which he gives the names of Iodo-glycerole:

	Gm. or mil.	
℞—Zinci iodidi	15	(ʒiv)
Aquæ	10	(fʒijss)
Iodi	25	(ʒvj)
Glycerini	50	(fʒxijss)—M.

Sig.—Apply to gums every second day.

His purpose in using the zinc iodide is to increase the strength of the preparation and to make it more astringent.

Zinci Oxidum.—Zinc Oxide [ZnO]. A very fine white or yellowish-white powder, without any gritty quality. It is odorless, tasteless and insoluble in water or alcohol. It is a feeble astringent, very mild and even soothing in effect, so that it may be applied to any irritated or denuded surface. Either in simple powder or in the official 20 per cent. ointment it is largely used in diseases of the skin. It is not used internally.

Vascular Astringents.

An important group of hemostatics comprises those whose chief action is upon the bloodvessels. The term styptic is often used to designate these. Either by local action when directly applied, or by stimulating the vasomotor nerve supply, they induce contraction of the muscular coat of the smaller arterial vessels, thus favoring coagulation by lessening the capillary circulation. They do *not coagulate* albumin. They are applicable only in hemorrhages of the smallest vessels, and particularly those in which unstriped muscle tissue is sufficiently abundant to be a factor in controlling the blood supply; for these agents act only through direct or indirect stimulation of the layer of unstriped muscle in the wall of the vessel. Where this is deficient, as in bone, they are likely to be inferior to coagulant agents. Those that act locally are of greatest importance to the dental practitioner and will accordingly be first considered.

Antipyrina.—PHENAZONE [$C_{11}H_{12}ON_2$]. Average dose, gr. 5 (0.3 gm.). This substance is obtained, by a series of chemical reactions, from pyrrol, a base found in coal-tar. Chemically it is phenyldimethyl-pyrazolon, which term shows the impracticability of using the chemical names of many of the newer drugs. Classed generally as an antipyretic and analgesic it was among the first of the coal-tar derivatives introduced to medicine. It occurs in colorless crystals, having a bitter taste, *neutral,* soluble in less than 1 part of water and in 1.3 parts of alcohol, also soluble in 1 part of chloroform and in 43 parts of ether. It is *not a coagulant.*

Its hemostatic value is purely local. If applied or sprayed upon a bleeding surface, in the strength of 10 per cent. solution, it has the power to cause contraction of the arterioles, and in this way will efficiently control any ordinary capillary hemorrhage. It will be less efficient than a coagulant hemostatic in checking hemorrhage from a tooth socket, because of the deficiency of muscle in the vessel walls in bone. It is a harmless drug when applied as above, for one-half of a fluidounce (15 mil.) of a 10 per cent. solution may be used without exceeding the maximum internal adult dose. It is useful in stopping epistaxis (nosebleed), the solution being sprayed into the nostril.

Its uses as anodyne and sedative are discussed in another place.

Incompatibility.—The aqueous solution is incompatible with a dilute solution of *carbolic acid;* also with *spirit of nitrous ether* when the latter is acid, as it is likely to be ordinarily; also with solution of *tannic acid.*

Suprarenalum Siccum.—DRIED SUPRARENAL GLANDS.—Average dose, gr. 4 (0.25 gm.). Unofficial preparations: Epinephrine, adrenalin, adnephrin, suprarenin (synthetic) and adrenin. A preparation much used is a solution of adrenalin chloride in 1000 parts of physiological salt solution.

The active principle of the suprarenal glands was first isolated by Abel (Cushny) and has been named epinephrine. It is found only in the medullary portion of the gland. Takamine later isolated another substance, adrenalin, which is claimed to have all the properties of the gland substance.

When an extract of the gland is injected into a vein, there occurs an immediate rise of blood-pressure which is more or less proportional to the strength of the extract. The rise in blood-pressure is accompanied by a slowing of the heart due to reflex stimulation of the cardio-inhibitory center excited by the rise of blood-pressure; when this reflex slow-

ing is rendered impossible by cutting the vagi the rise in blood-pressure may reach an extraordinary height. (Howell.)

The chemical nature of the extract has been worked out and has made it possible for the chemist to prepare a synthetic substitute together with a series of related substances having a similar nature.

By careful studies it has been found that the extract of the gland and related substances cause the rise in blood-pressure by stimulating the nerve fibers of the sympathetic nervous system distributed to the muscular coats of the bloodvessels. It is on this account that a weak solution of the extract is used to stop hemorrhage. While this substance will stop hemorrhage by constricting the arterioles, it reduces the coagulability of the blood and secondary hemorrhage may follow. It should be applied locally and is especially useful in capillary hemorrhage.

On account of its vasoconstrictor action it is a useful adjunct to the local analgesic solutions, making them more efficient by localizing the action and lessening absorption into the circulation.

The synthetic preparations are claimed to be more stable in composition and can be boiled in solutions which are for immediate use. For dental uses the usual dose is 1 drop of the 1 to 1000 solution of adrenalin, or of the synthetic preparations, to each cubic centimeter of the anesthetic solution with a maximum of 5 drops at any one time (Prinz).

Acidum Gallicum.—Gallic Acid [$C_7H_6O_5 + H_2O$]. Average dose, gr. 15 (1 gm.). An organic acid, prepared from tannic acid, having a rather uncertain reputation as a general styptic—*i. e.*, acting throughout the system after absorption into the circulation. It occurs in whitish crystals, having an astringent taste, soluble in 87 parts of water, in about 5 parts of alcohol, and in 10 parts of glycerin. It is *acid* in reaction. It does *not coagulate* albumin, therefore it has no appreciable local action. It may be given internally in a dose of from 5 to 20 grains (0.3–1.3 gm.). It is not much to be relied upon, still it is recommended by some in the hemorrhagic diathesis and to control internal hemorrhages that cannot be reached by local medication.

Ergota.—Ergot of Rye.—This fungus, which replaces individual seeds of the grain, is sometimes called "spurred rye." The pieces are one-half to one inch long, fusiform, slightly curved, purplish-black, hard, and breaking transversely.

Preparations:

Extractum Ergotæ. Average dose, gr. 4 (0.25 gm.).

FLUIDEXTRACTUM ERGOTÆ. Average dose, ♏ 30 (2 mils.). While this drug contains several alkaloids, none is regarded as representing its full action, therefore the preparations of the whole drug are preferred.

FIG. 3.—Ergotized rye.

Uses as a Hemostatic.—Ergot is really useful only as it induces contraction of unstriped muscle in the arterioles. Capillary hemorrhages that cannot be treated locally call for its administration by stomach or, in emergency, hypodermically. The fluidextract is the preparation most commonly employed, in doses of $\frac{1}{4}$–1 fluidram (1–4 mils.). In hemophilia (hemorrhagic diathesis) it is one of the drugs recommended. It should never be used in case of hemorrhage from a

good-sized vessel, for fear of increasing the flow through the rise of arterial pressure which the drug produces. (Plate I.)

It is one of the drugs used to control postpartum hemorrhage. This dangerous complication after labor is due to relaxation of the unstriped muscle which is so abundant in the parturient uterus. Ergot stimulates this to powerful contraction, thereby closing up the uterine sinuses from which the bleeding has occurred.

Cotarninæ Hydrochloridum.—COTARNINE HYDROCHLORIDE.—*Stypticin.*—[$C_{12}H_{14}O_3NCl$]. Average dose, gr. 1 (0.06 gm.). A yellow crystalline, odorless powder, derived from narcotin, an opium alkaloid. It is very soluble in water and in alcohol, and is *neutral.* It causes contraction of the unstriped muscular tissue of arterioles and of the uterus and is, therefore, used in hemorrhages from small vessels and from the uterus. It may be applied locally or given internally.

Hydrastininæ Hydrochloridum.—HYDRASTININE HYDROCHLORIDE [$C_{11}H_{11}O_2N.HCl$]. Average dose, gr. $\frac{1}{6}$ (0.01 gm.). Hydrastinine is an artificial alkaloid obtained by oxidizing hydrastine, an alkaloid of hydrastis. It is an odorless white powder, very soluble in water and in alcohol, and is *neutral* or *slightly acid.* It is used internally to secure constriction of arterioles both in hemorrhages and in catarrhal conditions.

Remedies that Favor Coagulation of the Blood by Reducing Blood-pressure.

Besides the application of cold, which has been considered in the earlier part of the chapter, there are several agents which comprise the group of arterial sedatives. The most prominent of these are:

Aconitum.—The root of *Aconitum napellus.* The tincture is the preparation commonly used, the average dose of which is ♏ 5 (0.3 mil.). For its precise action, see Plate XIV, under Sedatives.

Veratrum.—The root of *Veratrum viride.* This drug is so similar in action and uses to aconite as to require no special discussion here. Average dose of the tincture, ♏ 8 (0.5 mil.).

Remedies that Increase the Coagulant Property of the Blood.

Within recent years there has been a decided gain in our resources for treating cases of persistent hemorrhage due to various causes, including those that present deficient coagulation of the blood. The remedies employed may not all act in the same way, but each has been

PLATE I.

ERGOT.

A fungus replacing the grain of rye.

Classified as:

Oxytocic.
Vasoconstrictor.
Hemostatic.

Physiologic action:

Nervous System.

Brain. Not affected.

Medulla. Not affected by therapeutic doses.

Spinal cord. Stimulates center for uterine contraction in lower part of cord.

Muscular System.

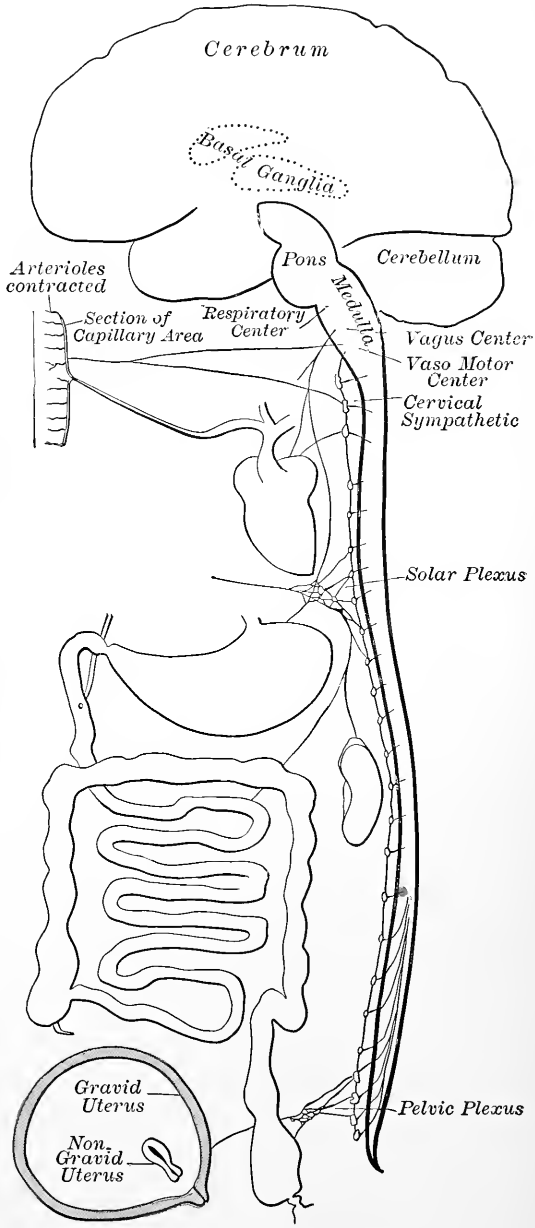
Stimulates unstriped muscle, —noted especially in the arterioles and gravid uterus. The vasoconstrictor effect, and the consequent interference with the capillary circulation, are so decided, that gangrene may result from its prolonged use.

Circulation. Arterial pressure may be increased, but not constantly.

Heart. May be slowed, but influence not definite.

Capillary area. Arterioles contracted chiefly by local vasomotor stimulation.

Uterus. Stimulates uterine contractions, mainly by local action upon the uterus.



Red color indicates stimulation.

sufficiently successful to entitle it to trial in any severe hemorrhage and particularly in cases of hemophilia. Since it is generally held that calcium salts are essential to the blood reactions that precede coagulation, these have come to be used with confidence in persistent hemorrhages. The chloride and lactate are efficient.

Calcii Chloridum.—CALCIUM CHLORIDE [$CaCl_2$].—[Do not confuse with chloride of lime, a chlorine disinfectant and bleaching agent.] Average dose, gr. 8 (0.5 gm.).

Chemically pure calcium chloride occurs usually in hard white fragments, which are very deliquescent, odorless and have a sharp, saline taste. It is *neutral*, soluble in 1.2 parts of water and in 10 parts of alcohol. When given internally it is believed to increase the coagulability of the blood. Good reports have been made of its value in hemophilia, used both locally and internally. A dose of 5–10 grains (0.3–0.6 gm.) may be given every four or six hours. For local application a 5 or 6 per cent. solution in water has been employed. Parry* reports a case of hemophilia in which a persistent and alarming hemorrhage from the gums was checked by the local application of a 6.25 per cent. solution (30 grains to the fluidounce). This drug certainly deserves a trial in any case of persistent hemorrhage.

Calcii Lactas.—CALCIUM LACTATE [$Ca(C_3H_5O_3)_2 + 5H_2O$].—Average dose, gr. 8 (0.5 gm.). This is the hydrated form of the salt. It occurs in white, granular form or in powder, odorless and nearly tasteless. It is soluble in 20 parts of water, almost insoluble in alcohol. Usually *neutral*. Though less soluble than the chloride, it is better tolerated by the stomach in case of prolonged use and seems to be equally efficient.

	Gm. or mil.	
℞—Calcii lactatis	6	(ʒiss)
Aquæ	120	(f℥iv)—M.

Sig.—One to two teaspoonfuls every four hours.

Gelatinum.—GELATIN.—Gelatin is soluble in hot water, acetic acid or glycerin. It is insoluble in cold water, but absorbs from five to ten times its own weight, forming a jelly. Obtained from the skins and bones of animals, gelatin may be contaminated with the bacillus of tetanus, the spores of which resist ordinary sterilization by boiling. Because of this, Wood† states that "the hypodermic use of *commercial* gelatin is not to

* Lancet, February 21, 1903.

† Pharmacology and Therapeutics, 2d ed., 1916, p. 325.

be thought of." The same danger of tetanus would obtain with intravenous use, with the added danger of thrombosis. Therefore none but a specially prepared gelatin* should be used. By mouth the dose is ℥ $\frac{1}{2}$–1 (15–30 gm.) of the gelatin, in form of a 10 per cent. jelly, every three or four hours.

Thyroideum Siccum.—Dried Thyroid Glands.—Average dose, gr. $1\frac{1}{2}$ (0.1 gm.). Both the extract of the thyroid gland of the sheep or of other domestic animals, and the dried gland substance itself, have given such striking results in the treatment of myxedema, that its administration has been resorted to experimentally in many conditions. Especially in disorders of nutrition and in diseases of the circulating fluids, where absence of the thyroid secretion might be a causative factor, this substance has been tried. Regarding its value in hemophilia, a very satisfactory result is reported of a case by Fuller.† The patient was a boy, aged fifteen years. Four maternal uncles and two elder brothers had bled to death. The patient had frequent copious hemorrhages from the nose and also bled severely with the loss of temporary teeth. For a year he had been in a very weak condition caused by spontaneous attacks of hemorrhage from the kidneys. After failure with the usual remedies, 5 grains (0.3 gm.) of thyroid extract were given three times daily. After the second dose the bleeding ceased. The case was reported nine months after, during which time there had been no recurrence of hemorrhage.

While this remedy may be useful in an occasional case only, it merits a trial in any condition attended by persistent hemorrhage.

Blood Serum.—Precipitated Blood Serum (not official).—An anhydrous, sterile powder, readily soluble in water. The usual dose is 8 grains (0.5 gm.) dissolved in sterile water and given subcutaneously, which is equivalent to 10 mils. of whole serum, and this may be repeated frequently. Human blood serum and also serum from the blood of the horse and the rabbit have been used with marked success in persistent hemorrhages where coagulation is deficient. The results reported by Welch‡ in cases of hemorrhages in newborn children,

* "Under the name of *Gelatina sterilizate pro injectione*, Merck has marketed a 10 per cent. solution manufactured from specially selected material and sterilized by heating to 115° C. Of this preparation ℥f 2–4, representing $1\frac{1}{2}$ to 3 drams of gelatin, may be injected subcutaneously, preferably after dilution with hot physiological salt solution." Ibid.

† Medical News, February 28, 1903.

‡ Am. Jour. Medical Sciences, 1910, p. 800.

and by Clowes and Busch* in a variety of cases, with reports by other observers, have given blood serum an important place among our remedies. The precipitated serum is preferred to fresh serum, and that of the horse is most satisfactory. The conclusions of Clowes and Busch in regard to this remedy are as follows:†

1. Blood serum is found to be of considerable value in the treatment of all forms of hemorrhage due to low blood coagulability.
2. Human serum is in no wise superior to that of a variety of animals.
3. Blood serum precipitated by means of a suitable mixture of acetone and ether is fully as effective as fresh serum, if not superior to it. Precipitated serum is freely soluble and possesses the advantages of being sterile, always available, and retaining indefinitely its capacity to stimulate coagulation of the blood.
4. The product obtained from horse serum appears to yield more uniformly satisfactory results than that obtainable from the sera of other animals, and very seldom exerts any deleterious influence.

Remedies that Cause Direct Pressure or Occlusion of Vessels.

Mechanical Hemostatics.—Under this heading are included surgical measures, such as pressure, ligatures and torsion. Pressure may be made directly upon the bleeding-point, or upon the artery of supply at some near point where it may be more effectually applied. Ligatures are intended to completely occlude the bleeding vessel, leading to its obliteration beyond. Torsion means twisting of a vessel. Small vessels that are not easily ligated may be treated in this way.

In case of persistent bleeding after extraction of a tooth, the most effectual remedy is pressure, for the application of which the tooth socket and the occluding jaw opposite are well arranged. A cork may be shaped with the knife and file to conform to the root of the extracted tooth, and, after sterilization by boiling, inserted into the bleeding socket. It is also recommended that warm wax or modeling compound be first inserted and the cork pressed into it. A rather simpler method will be to roll hemostatic cotton firmly into a cone of proper size to fit the socket tightly. Its fibrous nature aids coagulation, though the cotton plug will be less solid than a cork. After insertion, a cork or firm pad of gauze is placed between the plug occupying the socket and the opposing jaw, or the teeth contained in it, so as to have

* New York Medical Journal, January 4, 1913. † Ibid.

pressure of the necessary degree exerted by closure of the jaws. The pressure is usually maintained by a bandage passing under the lower jaw and about the head.

The *collodion group* act by exerting pressure. They are all inflammable, and must not be handled in the vicinity of a flame.

Collodium.—COLLODION.—A varnish that consists of a solution of 4 parts of pyroxylin in 75 parts of ether and 25 parts of alcohol. It is applied by means of a camel's hair brush upon a thoroughly dried surface. By rapid evaporation of the liquids its volume contracts, and considerable pressure is exerted upon the underlying tissue. It is applicable only to slight superficial hemorrhages.

Incompatibility.—Collodion is precipitated by *carbolic acid.*

Collodium Flexile.—FLEXIBLE COLLODION.—In this preparation 2 parts of camphor and 3 parts of castor oil are added to 95 parts of collodion. Its flexible character adapts it to use over movable parts, such as the lips, or about a joint.

Collodium Stypticum.—STYPTIC COLLODION (not official).—In this the formula is modified so as to contain 20 per cent. of tannic acid, which adds coagulant power and furnishes a more powerfully styptic combination.

The class of hemostatics would not be sufficiently discussed without mention of a drug not usually included in the class, but one that is nevertheless valued highly in its distinct application to cases of hemorrhage.

Opium.—(For description and detailed action, see under Sedatives.) This drug, of general systemic action, is mentioned here only for its value in aiding to restrain certain kinds of hemorrhage. It cannot be classed with any of the preceding drugs, for it has neither coagulant nor vasoconstrictor action; but it is by its power to put the system at rest that it becomes so valuable in the treatment of internal hemorrhages. Bleeding from the lungs requires that cough be restrained and respiratory excitement allayed; intestinal hemorrhage requires that the bowel be held quiet; and in either case mental excitement and apprehension must be removed. Opium, or its alkaloid, morphine, will accomplish all of this. In fact, the element of nervous excitement may aggravate almost any kind of bleeding and call for the use of opium or morphine for its removal. Morphine in moderate dose is usually employed, by stomach or, if the case is urgent, hypodermically.

CHAPTER X.

DETERGENTS, ANTACIDS AND ALKALIES.

DETERGENTS.

The term detergent, meaning a cleansing agent, applies rather to one of several uses to which certain agents are put. These, in their more important designation, are usually alkalies or antiseptics; therefore, it seems unnecessary to make a separate class of detergents. Many of the alkalies and milder antiseptics are well adapted to the cleansing of the mouth, teeth, throat and nasal chambers, while the stronger disinfectants and even corrosive agents are adapted to the cleansing of foul ulcers, putrescent pulp canals, etc. For the former uses, agents that do not coagulate albumin will be most useful, for a certain degree of penetration, especially into the recesses between the teeth, is desirable, which might be hindered by coagulation. For the latter uses, destruction of diseased tissue, bacteria and decayed matter is necessary, calling at times for the strongest chemical drugs. Again, in dentifrices one kind of detergent contributes the scouring quality, as prepared chalk; another kind will thoroughly cleanse all surfaces and remove fatty matter, as soap; and still another may be desired to exert a solvent or a penetrating influence. Hydrogen peroxide is a very important detergent besides being an antiseptic. Its action is a double one: (1) Upon coming into contact with blood, pus or loosely organized tissue, it is decomposed, yielding nascent oxygen, by which it acts as an oxidizing agent and antiseptic. (2) The freeing of oxygen causes gaseous expansion, by which foul materials may be loosened and carried away from the tissues mechanically.

ANTACIDS (ALKALIES).

Antacids are agents that are capable of neutralizing acids by reason of either their alkaline or basic properties. Alkalies are known by their power of changing the color of red litmus to blue.

The action of antacids is always chemical, for the acid character of a substance is lost only through combination or decomposition. In

some instances, where a simple alkali is used, such as lime-water or magnesia, the chemical change is a simple one, while with the use of sodium bicarbonate or prepared chalk, there is decomposition with evolution of carbon dioxide, and new combinations result in which the acid quality is lost.

The importance in dentistry of the various substances belonging to this class is readily appreciated. With the tendency toward acidity of the fluids of some mouths; with the vitiation of the same in disease; and with the very common presence of fermentation in food particles which are allowed to remain between the teeth, we have factors of prime importance in the causation of caries; and in the recognition of these factors we have also the basis upon which to found our prophylaxis. The judicious use of antacids becomes a necessity, at least for the purpose of meeting temporary conditions, recognizing, however, that proper care of the teeth requires also proper care of the individual as to general health and all nutritive processes.

As a rule that scarcely admits of exception, all mouth washes for continued use, and all dentifrices, should be alkaline or antacid; but in the prevention of caries we recognize that antacids *per se* do but one thing—they neutralize acids. The prevention of acid formation is equally important, and involves, besides strict local cleanliness, the use of an antiseptic to arrest fermentation, which is the very common source of the acid, or the use of an agent that is both antacid and antiseptic. Furthermore, when acidity of the oral secretions persists in spite of local treatment, the condition of the general system must be considered, particularly as to disorders of digestion or errors of diet, which may be the cause of the condition.

The difference in *solubility* of the several antacids in ordinary use gives them a wide range of adaptability in dental practice. To illustrate: For the purposes of a mouth wash a soluble alkali is needed; here sodium bicarbonate, lime-water or borax are applicable. For use in the mouth of a young child, where rinsing the mouth is impracticable, the gelatinous hydrated magnesia may be applied quite thoroughly by means of a cotton swab, or injected between the teeth and the cheeks, where, because of its thick consistence, it will adhere and remain in contact for some time; and, again, in case of erosion, where a soluble substance would be rapidly washed away, the insoluble prepared chalk may be packed between and about the teeth, and its neutralizing action will continue for hours, or through the night if applied at bedtime.

The excessive or continuous use of antacids may disturb gastric digestion to just the extent that they are allowed to reach the stomach during the first two or three hours after meals. During this time the natural acidity of the gastric juice is needed and the entrance of much alkali into the stomach might hinder digestion by neutralizing the acid. Otherwise no harm is likely to arise from their use.

Soaps.—Soaps are compounds of the ordinary fat acids (oleic, palmitic and stearic) with bases. In the process of saponification, by boiling a fat with a base, the fat is decomposed, glycerin is set free, and the fat acids combine with the base. Strictly speaking, all metallic salts of oleic, palmitic and stearic acids are soaps; but only those of potassium, sodium and ammonium are soluble. Whatever the consistence of the oil or fat employed, its reaction with sodium will produce a *hard* soap and with potassium a *soft* soap. Lead plaster is a familiar example of an insoluble soap.

Sapo.—Soap.—*White Castile Soap.*—It occurs as a white or whitish solid prepared from sodium hydroxide and olive oil. It should be hard, but easily cut when fresh, and free from rancid odor. It has an unpleasant alkaline taste and an *alkaline* reaction. It is soluble in water and in alcohol. It contains about 21 per cent. of water, which may be largely removed by drying at an elevated temperature, when the soap may be more readily pulverized. It is capable of dissolving fats, which property gives it its great value. Medicinally it is alkaline and somewhat antiseptic, possessing detergent qualities in marked degree. Its chief dental use is in dentifrices, where, in powdered form, it may be mixed with any other agent in common use. As soap is irritating to the mucous membrane, unless well diluted, the mixture should not contain more than 25 or 30 per cent.

Colored or marbled castile soap is less pure, as it contains ferruginous coloring matter. It is more strongly alkaline, harder, containing only about 14 per cent. of water, and is, therefore, more economical for ordinary uses.

Sapo Mollis.—Soft Soap.—A soft, yellowish or brownish mass, prepared from potassium hydroxide and cotton-seed oil, and containing an excess of the alkali. It is freely soluble in water and in alcohol. It has a slight odor and alkaline taste and is irritating to mucous membranes because of the free alkali contained.

It is used preparatory to surgical operations as a cleansing agent for the hands of the operator and the site of operation. For this use it is diluted with alcohol and the parts are thoroughly scrubbed with

sterile brush, the solution of soft soap and water. The tincture of soft soap (*linimentum saponis mollis*) contains 65 per cent. of the soap.

Incompatibility.—Soluble soaps are incompatible with all *acids* and with *earthy* and *metallic salts;* they are precipitated in hard water, or in a solution of *corrosive sublimate*, as an insoluble soap.

Sodii Bicarbonas.—Bicarbonate of Sodium [$NaHCO_3$].—A white, opaque powder, having a mildly alkaline taste, soluble in 10 parts of water, insoluble in alcohol. It is *alkaline* in reaction. Average dose, gr. 15 (1 gm.).

Although the carbonates of the alkalies are more soluble and more strongly alkaline than the bicarbonates, the latter are preferred for dental uses because they are milder and less unpleasant to the taste. For similar reasons the sodium salts are preferred to the potassium. Sodium bicarbonate is the one usually selected for internal use, as it answers every purpose of an alkali without being at all irritating. In stomatitis due to fermentative conditions and in constitutional disorders that cause vitiated oral secretions, this drug is useful used alone or in combination with an antiseptic. As a mouth wash or gargle it may be used freely in saturated solution (10 per cent.). It may enter into dentifrices simply as an alkaline ingredient, as it is not antiseptic nor does it contribute any scouring quality. It is useful to neutralize the mouth after any acid or acid iron preparation has been taken or used locally.

It is used also, by direct application, to lessen the sensitiveness of dentine when this is due to acidity. Internally the drug is used to neutralize hyperacidity in the stomach, and in the various acid intoxications of the system, such as rheumatism. The internal dose is 5–30 grains (0.3–2 gm.). In connection with sterilization of instruments by boiling, sodium bicarbonate is oftentimes added to the water in order to lessen the liability of rusting.

Incompatibility.—This salt is incompatible with all *acids*, producing effervescence with liberation of carbon dioxide. In solution it is changed by *boric acid* into sodium carbonate and borax, with liberation of carbon dioxide. (If carbonate of sodium be present, reaction may occur with either magnesium sulphate or mercuric chloride in solution, a brown-red precipitate being thrown down.)

Sodii Boras. — Borate of Sodium. — *Borax* [$Na_2B_4O_7 + 10H_2O$]. Average dose, gr. 12 (0.75 gm.). It occurs in colorless crystals or white powder, having an alkaline taste, soluble in 15 parts of water and in about 1 part of glycerin, insoluble in alcohol. It is *alkaline* in reaction,

non-irritating to tissues, and its taste is bland and sweetish. The solution in glycerin is acid in reaction. (See below, under Incompatibility.)

This salt is also known as sodium biborate, tetraborate and pyroborate. It occurs naturally in many volcanic regions, our American supply coming chiefly from Nevada and California. It is also prepared artificially upon a commercial scale.

In borax we have an agent that is both alkaline and antiseptic, and that may be used freely in saturated solution (6.6 per cent.). It is, therefore, admirably adapted to all uses that call for a mouth wash possessing the above qualities. In stomatitis and in thrush especially it is a superior agent. The latter disease occurs mostly in young infants where a mouth wash cannot be so well employed. Here, before the eruption of any teeth, we may use a saturated solution in glycerin, made by dissolving the powdered borax in hot glycerin, which will insure saturation when it has cooled. Glycerin itself is a preservative, and the resulting thick, sweet solution may be applied by means of a swab to all parts of the infant's mouth. In dentifrices borax will contribute antacid and antiseptic properties. This drug is seldom given internally.

Incompatibility.—Borax in saturated aqueous solution is decomposed by *mineral acids,* with the precipitation of boric acid, which is slightly less soluble. A white precipitate is also thrown down by *corrosive sublimate.*

Special interest attaches to borax because of its peculiar behavior with certain other substances. Thus,* "It is incompatible with *mucilage of acacia,* causing gelatinization, which can, however, be prevented by the presence of sugar; it precipitates many *alkaloids* from their solution, such as cocaine, morphine, atropine, quinine, etc., except in the presence of glycerin; it forms a damp, almost moist, mixture when triturated with *alum;* in the presence of glycerin it decomposes *alkali carbonates* with effervescence; and, lastly, while an aqueous solution of borax shows an alkaline reaction toward litmus, a solution in glycerin has a decided acid reaction, which is changed to alkaline upon large dilution with water."

Liquor Calcis.—SOLUTION OF CALCIUM HYDROXIDE.—*Lime-water.*—Average dose f℥ 4 (15 mils.) or a tablespoonful. An aqueous solution containing not less than 0.14 per cent. of calcium hydroxide [$Ca(OH)_2$].

* The National Standard Dispensatory, third edition, 1916, pp. 1487–8.

It is readily prepared by treating freshly slaked lime with water. It is strongly *alkaline* in reaction, almost tasteless and very agreeable to the stomach. It may be used freely as a mouth wash and to correct undue acidity of the stomach. For the latter purpose it is very commonly added to the food of infants, especially in the digestive disorders occurring during the summer, when the milk so easily loses its normal alkaline quality.

Incompatibility.—*Carbon dioxide* gas produces in lime-water a cloudiness, due to calcium carbonate. *Oxalic acid* produces a white precipitate of calcium oxalate. With *corrosive sublimate* a yellowish precipitate occurs, and with *calomel* a black deposit.

Magnesii Oxidum.—Light Magnesia.—*Magnesia* [MgO].—Average dose, gr. 30 (2 gm.). The light magnesium oxide is prepared by exposing light magnesium carbonate to a dull-red heat. It is a white, very light powder, having a slight earthy taste and *alkaline* reaction. It is insoluble in alcohol, almost insoluble in water, but when mixed with 15 parts of water and allowed to stand for half an hour it gelatinizes, forming magnesium hydroxide or "milk of magnesia." (See Magma Magnesiæ, below.) This drug is an agreeable antacid for stomach administration, and is at the same time laxative. This combination of properties makes it a useful agent for the treatment of intestinal disorders of childhood, the alkaline quality serving to neutralize any undue acidity, and the laxative action ridding the bowel of offensive contents. When used thus internally it should be given in not less than 20 parts of water to prevent the formation of a gelatinous mass.

Magnesia should be kept from exposure to air, as it slowly absorbs moisture and carbon dioxide, forming a carbonate.

Magma Magnesiæ.—Milk of Magnesia.—Average dose f℥ $2\frac{1}{2}$ (10 mils.). A thick, white liquid containing about 7 per cent. of magnesium hydroxide [$Mg(OH)_2$] in suspension in water; *alkaline* in reaction. Milk of magnesia is one of the most useful agents to neutralize acids in the mouth, being ranked first by some practitioners. This preparation is easily made in the way mentioned above and it keeps well. Its gelatinous consistence causes it to adhere to the teeth and remain about them for a considerable time, which is a decided advantage. In infants it may be applied by means of a cotton swab to the inside of the cheeks and throughout the mouth. It may be used freely in any mouth and at any age. Given internally, it has the antacid and laxative action of magnesia, the latter being aided by following the dose with lemon juice or other mild acid.

Incompatibility.—Magnesia is neutralized by *acids.*

Creta Præparata.—PREPARED CHALK [$CaCO_3$]. Average dose, gr. 15 (1 gm.). This substance is one kind of calcium carbonate. It occurs in form of a whitish powder, which is often moulded into the shape of small cones. It is odorless and nearly tasteless, almost insoluble in water, insoluble in alcohol, soluble in acids with effervescence and chemical change. It is not properly an alkaline substance, but an antacid, *i. e.*, it neutralizes acids, but does not turn red litmus blue. Its action consists of a chemical union with any free acid, which displaces the carbonic acid of the chalk. It may be used freely internally, as an antacid in gastric and intestinal disorders. While solubility of a drug is usually desirable in order to have rapid action, the insolubility of prepared chalk gives it a special place in dentistry. Having a mild scouring quality, and being antacid, it holds first place as a basis for tooth powders. Its insolubility also gives it a prolonged action as an antacid so that in a mouth with a marked tendency to acidity it may be packed between and about the teeth upon retiring, and its action will continue during the night. This use is regarded as very important in progressive cases of erosion, where the damage occurs mostly at night, when there is less saliva secreted and, accordingly, the secretions of the mouth do not become so well mixed, the mucus remaining upon the surfaces of the teeth and about the gum margin. The extreme sensitiveness of the dentine, which is present in these cases, may also be lessened by the continuous use of this agent within the cavities of erosion and decay and about the teeth. The accepted belief that sensitiveness of dentine is often due to irritation by acids, points to the use of prepared chalk during the preparation of any cavity where sensitiveness is marked. It is well to continue its use during several days preceding the final preparation for filling. (See Index of Drugs for preparations for internal use.)

Incompatibility.—In contact with *acids* chalk decomposes with effervescence, caused by the liberation of carbon dioxide.

DILUENTS. WATER. MINERAL WATERS.

The increasing recognition of various autointoxications of the human system as the most disturbing factors in many diseases, brings into prominence the use of diluents, especially water, in the aid of normal cell function through free elimination. Particularly after full development of the body, in other words after the play period of life has passed, the tendency to less active and a lessened amount of exercise, favors

deficient oxidation of food substances and waste tissue materials, with resulting accumulations of partially elaborated products, which are more or less deleterious. A distinct group of diseases related to such causes, including gout, so-called lithemia, fermentative digestive disorders, chronic rheumatism, etc., give evidence of the extreme importance of aiding cell elimination throughout the body. If with lessened exercise the usual amount of food is still taken, the conditions are aggravated, a superabundance of nutriment being furnished to the tissues whose oxidation processes are below normal. Moreover, as age advances, with development completed,* many of the capillary blood-vessels disappear because no longer needed. The capillary circulation is accordingly less active and, with the factors of excessive food material and deficient oxidation coöperating, the tissues easily become clogged, so to speak, laying the foundation for the diseases mentioned. The presence of arteriosclerosis, which means hardening of the walls of the arteries, adds another contributing factor by lessening the uniformity of blood supply to the capillaries. The relation of these conditions to oral pathology is being emphasized today in classification and treatment of pericemental and alveolar diseases.

Uric acid is recognized as a product of partial oxidation of nitrogenous waste, and has been regarded as a prominent factor in gouty disorders. At the present time, however, doubt is being thrown upon its importance as a poison to the system. Nevertheless it stands with a group of substances arising in the body through faulty cell activity, some of which are acid in nature. For the double purpose of washing these substances out of the tissues into channels of elimination and of diluting them, it is advisable to use water freely, with or without alkaline salts for antacid effect. Various alkaline mineral waters are taken with good results, and the salts of lithium have had a recent extensive use; but many physicians now give preference to pure water. Distilled water, because of its greater solvent power, being devoid of salts, is preferred in some conditions. In whatever kind, the taking of water in the quantity of one or two quarts daily is an important part of the constitutional treatment of these conditions. Pure water is a diuretic and the addition of certain salts will increase this action, while others will induce a cathartic action.

While the natural mineral waters are useful according to their saline and alkaline constituents, they are not necessarily superior to simple

* Balfour, The Senile Heart, MacMillan & Co., 1894, p. 14.

solutions of the cathartic and diuretic salts, while the latter permit of modification which places the kind and degree of the saline action under our control. (See Cathartics and Diuretics.)

Certain artificial combinations, in imitation of the formulas of popular mineral waters, are upon the market, *e. g.*, artificial Carlsbad salts. These seem to meet the demand, but their employment, as well as that of any mineral water, should be based upon proper discrimination as to indications for their use.

CHAPTER XI.

ANTISEPTICS.

The term antiseptic in a general sense applies to the antagonism of sepsis—*i. e.*, to whatever measures are employed to prevent the growth and propagation of disease-producing bacteria, also to counteract their influence and to remove their noxious products. If, however, we analyze modern antiseptic treatment, we find that the agents and means employed vary as to the precise part they play in bringing about the result. One agent will kill the bacteria; it is, therefore, a *germicide*. Another will not only destroy bacteria, but will remove the noxious properties of putrefaction and fermentation; this is a true *disinfectant*. Another will inhibit the growth and propagation of bacteria without destroying them or removing their noxious products; this cannot be designated otherwise than as a *simple antiseptic*—preventing sepsis, but not removing it when present. A *deodorant* is an agent that removes or corrects an offensive odor.

It is impossible, however, to make a distinct classification in accordance with these terms, for the reason that many agents belong to one or another class, according to the strength in which they are employed, being in strong solution germicidal or disinfectant, and in weak solution simply antiseptic. Other conditions, such as character of solvent, temperature of solution and character of bacteria, also modify our designation of the several agents.* An antiseptic may be germicidal to one kind of bacterium and only inhibitory to the growth of another. To the writer it seems better to employ the term *antiseptic* in its general inclusive sense, to cover all agents employed to prevent, counteract and remove the influence of disease germs, and to further designate differences of action by using the adjective terms *germicidal* and *disinfectant*.

* The efficiency of antiseptics can be stated only in a relative manner, since, as yet, there are no generally accepted standards. Rideal and Walker have proposed the "phenol coefficient" but the results have not justified its general acceptance. Briefly stated it means the result arrived at by dividing the figure indicating the degree of dilution of the disinfectant that kills an organism in a given time by that expressing the degree of dilution of phenol that kills the same organism in the same time under exactly similar conditions.

The intelligent use of antiseptics has been a matter of development during the past forty years, following closely the progress made in the science of bacteriology. When Pasteur in 1857 proved that the processes of fermentation and putrefaction were caused by the presence and growth of organisms, the way was prepared for investigation of septic conditions and special diseases. In 1875 Lister set forth the germ theory as applied to the infection of wounds. His work and methods were a great step toward realizing the aseptic surgical methods of today and are referred to by an eminent surgical writer* as having "brought about an entire revolution in surgery and surgical technic, and an entire reversal of the statistics of operations; where thousands formerly died, thousands now live, their lives being indirectly due to the labors of this one man and his following."

Since then the specific organisms of many diseases have been discovered and the application of antiseptic agents has become more precise and the results more definite.

In dental practice antiseptics must be regarded in relation to widely differing structures, as presented by the teeth, in their very hard mineral character, by the softer tissues of the mouth, and by the extremely delicate and sensitive tooth pulp. Indeed, two quite distinct fields are before the dental specialist in his study of antiseptic therapeutics. He has now to select his agents for *mouth disinfection* and again for *tooth disinfection*. For mouth treatment his antiseptics must be selected with regard to safety of the soft tissues; for tooth disinfection the application is of such limited extent, and the soft structures are so well excluded, that the main question is that of efficiency, the very strongest escharotics being eligible for use; then also treatment of the tooth pulp will require the selection of agents especially adapted to its condition. These considerations will lead to the use of the terms "mouth disinfection" and "tooth disinfection" in the discussion of antiseptics.

The ideal condition to be aimed at in all surgical work is that of **asepsis**, or absence of disease germs. The operator seeks to begin his operation with perfect asepsis. To this end his instruments are sterilized by boiling, and the dressings by dry heat at a temperature of 230° or over, while his hands and the site of operation are treated with suitable disinfectants. Asepsis of the mouth is difficult of attainment, but the site of operation may be made relatively aseptic after exclusion of the fluids by a sterile rubber dam, and the condition then maintained

* Park's History of Medicine, second edition, p. 261.

through the use of sterile instruments by sterile hands. The application of tincture of iodine to the site of operation is most relied upon today to secure asepsis.

The importance of thoroughly **sterilizing all instruments** that have been used in the mouth, after each dental operation, must be insisted upon. There can be no doubt that one must frequently operate in a syphilitic mouth without being aware of it, because the lesions may be slight or invisible. In secondary syphilis the danger of carrying the disease to another mouth or of infecting a chance lesion upon the hand is very great, and preventable with certainty only by sterilization of instruments and appliances. Alcohol has been regarded as a disinfectant for this purpose, but its value is questionable. Absolute certainty should require sterilization by heat.

Acidum Boricum.—Boric Acid.—*Boracic Acid* [H_3BO_3].—Average dose, gr. 8 (0.5 gm.). This occurs in transparent, colorless scales or crystals, nearly tasteless, soluble in 18 parts of water, 18 parts of alcohol, and 4 parts of glycerin. It is *slightly acid* in reaction. This substance is found in various parts of the globe chiefly in the form of natural borates, the American market being supplied from the borax regions of California.

The saturated aqueous solution of this drug (5.5 per cent.) is largely used as a mild antiseptic wash. It is non-irritating, therefore may be applied to the most delicate tissue. As an eye wash it is much used. It may be employed freely as a mouth wash, the only objection being its slight acidity. However, it must be said that it possesses no real advantage over its sodium salt. In powdered form it is used in tooth powders or dusted upon ulcers or wounds.

Incompatibility.—In aqueous solution boric acid is decomposed by *carbonates,* with the formation of borates.

Glyceritum Boroglycerini.—Glycerite of Boroglycerin.—Whenever a stronger preparation of boric acid than the saturated solution is desired, it may be had in the official glycerite of boroglycerin, which contains 31 per cent. of boric acid incorporated by chemical union with glycerin. This may be used in full strength or diluted. It is *neutral* in *reaction.*

Sodii Boras.—Borax.—Average dose, gr. 12 (0.75 gm.). This salt has been discussed under Antacids. As an antiseptic it may be used freely in saturated solution (6.6 per cent.) as a mouth wash, or the crystal may be allowed to dissolve in the mouth. Borax deserves a large use as a mild antiseptic since it possesses every essential quality

of a mouth antiseptic, though one of the class of weaker agents. It is *alkaline,* non-irritating, almost tasteless and non-toxic. Dobell's solution* is a very useful combination.

A saturated solution in glycerin (equal parts of each) is very efficient in the removal of the thrush fungus (oïdium albicans), which is so often seen in the mouths of bottle-fed infants. The thick consistence of this solution is advantageous in that it thereby adheres to the mucous membrane for some time. It should be applied several times daily.

Sodii Perboras.—Sodium Perborate [$NaBO_3 + 4H_2O$].—Average dose, gr. 1 (0.06 gm.). It occurs as white granules or powder, odorless, with a saline taste, stable in cool dry air, but losing oxygen in warm or moist air; soluble in water; *alkaline* in reaction. It should contain not less than 9 per cent. of available oxygen.

Sodium Perborate makes an efficient antiseptic mouth wash in ulcerative conditions of the mouth. It is important that it be prepared fresh each time, as the solution does not keep well. A teaspoonful in one-half glass of water is a proper strength. It produces its action by the liberation of nascent oxygen.

Phenol.—Carbolic Acid.—Average dose, gr. 1 (0.06 gm.). This substance has been considered in its action upon the tissues, under Escharotics. In dilute solutions it is one of the most generally useful antiseptics. Although *slightly acid* in reaction, this substance is not an acid, chemically speaking. It is a *coagulant* when used in strong solution, and while this property may be a factor in its antiseptic action, its germicidal power may be thereby lessened by interference with penetration.

Phenol Liquefactum.—Liquefied Phenol, containing not less than 87 per cent. of absolute phenol, is convenient for ready use and for diluting.

Phenol is soluble in about 15 parts of water, giving a saturated solution of about 6 per cent. This is too strong for use upon mucous membranes,

* The formula of Dobell's solution, as given in the National Formulary under the title *Liquor Sodii Boratis Compositus* is:

		Gm. or mil.	
℞—Sodii boratis		15	(ʒiv)
Sodii bicarbonatis		15	(ʒiv)
Phenolis (crystals)		3	(gr. xlv)
Glycerini		35	(f℥j)
Aquæ	q. s. ad	1000	(Oij)

Dissolve the salts in one-half of the total quantity of water, then add the glycerin and the phenol, previously liquefied by warming, and, lastly, enough water to make up the total quantity.

but may be used upon the skin with care.* It is the proper strength for occasional disinfection of the hands, but its frequent use will make the skin rough, because of its coagulant action. As a mouth-wash or gargle it has the advantage of being slightly analgesic, but it should not be used stronger than 1 per cent. The slight acidity may be counteracted by combining a solution of sodium bicarbonate with it. For the purpose of tooth disinfection the pure phenol may be used in small quantity with due care.

It is remarkable that the continuous application of a solution as weak as 5 per cent. has been followed by gangrene, the result probably of thrombosis. This is especially liable to occur in a finger or toe where all vessels of supply are equally affected. The local analgesic action undoubtedly aids in lowering the vitality of the part and prevents painful sensation, which otherwise might give warning of the danger.

It may be said of this agent that, having been one of the first substances proposed as an antiseptic and disinfectant, it has held its place for more than forty years as one of the best drugs of the class. A solution of 1 in 250 will quickly destroy lower forms of vegetable life and check fermentation, a 1 per cent. solution may be relied upon as a general antiseptic, while a 5 per cent. solution is an efficient disinfectant.

As to its germicidal power, Harrington found that a 5 per cent. solution destroyed the *Staphylococcus pyogenes aureus*, the most common and most resistant pus organism, in two minutes; a 2.5 per cent. solution required four minutes.†

In saturated solution it is useful to keep instruments in sterile condition during an operation. It has no action upon metals; therefore instruments may be disinfected by its use in full strength, bearing in mind always that any albuminous matter will be coagulated by it instead of being removed. The combination known as liquor sodii carbolatis‡ contains 50 per cent. of carbolic acid.

* A wet dressing of not stronger than 5 per cent. phenol has caused gangrene of a finger, after a twenty-four hour application. See Hare's Therapeutics, thirteenth edition, 1909, p. 400.

† Annals of Surgery, October, 1904.

‡ *Liquor sodii carbolatis* (N.F.) corresponds very closely to the proprietary preparation known as phenol sodique. It has the following formula:

	Gm. or mil.
℞—Phenolis (crystals)	50
Sodii hydroxidi	3 5
Aquæ	46 5

Dissolve the soda in the water, add the phenol, and warm gently until it is dissolved.

This preparation should be freshly made. Used in full strength this combination would be caustic.

Internally phenol is a valuable antiseptic. In doses of $\frac{1}{2}$–2 minims (gm. 0.03–0.12), well diluted, it is used to arrest fermentation in the stomach and intestines, an advantage of its use being that it does not disturb digestion.

When employing this drug, it must always be borne in mind that it is a poison—*corrosive* when applied in full strength to tissue; and also a *systemic poison* when absorbed in quantity, producing irritation of the kidneys which may result in nephritis; therefore, caution should always attend its use, and in view of the frequency of poisoning by carbolic acid every practitioner should be prepared to treat the same in emergency. Albumin is a true antidote, while alcohol has some restorative action upon tissues; soluble sulphates have been employed. (See under Escharotics.)

Incompatibility.—Phenol will coagulate *albumin* and *collodion*. In aqueous solution a white precipitate occurs with *bromine* water, with *ferric chloride* a violet color is produced, and with solution of *antipyrin* a white precipitate occurs. When the saturated aqueous solution is mixed with a solution of *cocaine hydrochloride* a white precipitate may occur.

Cresol.—TRICRESOL.—*Cresylic Acid* [C_7H_8O].—Average dose, ♏ 1 (0.05 mil.). A mixture of isomeric cresols obtained from coal-tar. It is a nearly colorless liquid, becoming yellowish or brownish upon prolonged exposure to light. Its odor is similar to that of phenol. It is soluble in 50 parts of water and in alcohol and glycerin. The uses of this substance are the same as those of phenol. It is believed to be a more powerful disinfectant. A 5 per cent. solution has been found to destroy *Staphylococcus pyogenes aureus* in two minutes.*

Liquor Cresolis Compositus.—Lysol.—This solution contains 50 per cent. of cresol, with linseed oil and potassium hydroxide. It is liquid cresol soap. It mixes with water readily and in solution of from 1 to 5 per cent., it is largely used as a general antiseptic wash and disinfectant. It is a good hand disinfectant, although its odor may be objectionable.

Trichlorphenol [$C_6H_2Cl_3OH$] (not official).—The action of chlorine upon phenol produces a series of bodies whose antiseptic power exceeds that of phenol. Of these trichlorphenol is a definite crystalline substance, soluble in alcohol and ether. According to Nencki† a 2 per cent. solution was found to be more active than a 5 per cent. solution

* Harrington, Annals of Surgery, October, 1904.

† U. S. Dispensatory, eighteenth edition, p. 1615.

of phenol and only a little weaker than 1 to 1000 solution of bichloride of mercury.

Creosotum.—CREOSOTE.—*Oil of Smoke.*—Average dose, ♏ 4 (0.25 mil.). A mixture of phenols, chiefly guaiacol and creosol, obtained by distillation of wood-tar. In addition to the discussion of this substance in the class of irritants, its use as an antiseptic claims consideration at this place. Obtained usually from beechwood-tar by distillation, creosote is always liquid, nearly colorless when fresh, but becoming yellowish. The U. S. P. states that it should not readily become brown on exposure to light. It is *neutral* or only *faintly acid* to litmus paper. It is soluble in about 140 parts of water, and more freely in absolute alcohol, ether, chloroform and oils. In some respects it resembles liquefied phenol, but the latter acquires a pink or reddish color with exposure; in odor it is somewhat similar, although decidedly smoky and unpleasant. It is less useful in dental practice, because of its odor and also the fact that it discolors teeth by continuous treatment. The chief points of difference between the two substances are given below:

PHENOL.	CREOSOTE.
Crystallizable.	Always liquid.
A definite chemical compound.	A mixture of phenols.
Coagulates collodion.	Does not coagulate collodion.
Soluble in glycerin.	Insoluble in glycerin.
Soluble in about 15 parts of water.	Soluble in about 140 parts of water.

In antiseptic power creosote surpasses phenol,* and its internal use is safer. In recent years it has been used extensively as an internal remedy in the treatment of pulmonary tuberculosis, tolerance to quite large doses being readily acquired. It has a local analgesic and sedative effect, which makes it a valuable inhalant.

In full strength creosote is an excellent tooth disinfectant, being preferred to carbolic acid by some, because it has little or no coagulant action.† It penetrates more deeply, but is less corrosive. As it is apt to discolor tooth structure it is not to be used in teeth that are visible.

As a mouth wash it may be used freely in saturated aqueous solution (0.66 per cent.), but its unpleasant odor and taste are objectionable.

* See table on p. 137.

† It is stated by some authorities that creosote contains some carbolic acid and that it coagulates albumin. This was formerly true, when pure creosote was difficult to obtain and adulteration with carbolic acid was common; but at the present time pure creosote is easily obtainable and it has little coagulant action. However, creosote being a mixture of substances, its properties may vary slightly.

The official **aqua creosoti** is prepared with 1 per cent. of creosote, in order to insure saturation.

Although there has been a tendency toward eliminating creosote from dental uses, there is good reason to believe that it is a valuable antiseptic agent in the treatment of putrescent root canals. On the whole, it may be said that in dental practice creosote is used little compared with phenol, though a stronger antiseptic.

Poisoning by this drug would occur by swallowing a quantity of it pure. The symptoms would be those of irritant poisoning. It has no definite chemical antidote. Emetics would be indicated, followed by demulcents.

Creosoti Carbonas.—CREOSOTE CARBONATE.—A liquid mixture of carbonates of several constituents of creosote, chiefly guaiacol and creosol. Average dose, ♏ 15 (1 mil.). This agent, being a mixture of substances, varies as to color, odor and taste. It may be colorless, odorless and tasteless, or it may be yellowish and have a slight odor and taste of creosote. It is insoluble in water, but soluble in alcohol and in fixed oils. It is less irritating for internal use than is creosote and, with similar uses in pulmonary diseases, it can be given in larger doses.

Guaiacol [$C_7H_8O_2$].—Average dose, gr. 8 (0.5 gm.).—A crystalline solid obtained from creosote and constituting from 60 to 90 per cent. of the latter. It melts at 82.4° F. It is soluble in 53 parts of water, 0.8 part of glycerin, but separating upon addition of water, and also soluble in alcohol and ether. Being a definite compound, it forms a number of combinations, some of which, as well as itself, are used as substitutes for creosote for internal administration. Guaiacol has been used as a vehicle for cocaine in its application by cataphoresis.

Guaiacolis Carbonas.—GUAIACOL CARBONATE [$(C_7H_7O)_2CO_3$].—Average dose, gr. 15 (1 gm.). A white crystalline powder, insoluble in water, soluble in 60 parts of alcohol, neutral and almost tasteless.

Alcohol.—This drug, fully considered in other places as astringent and stimulant, has a well-founded reputation as an antiseptic. Its action upon bacteria is probably due to its power of abstracting water and of coagulating albumin. It is less valuable as a disinfectant than as a simple antiseptic and as a vehicle for stronger agents of this class. It must be used in strength of 40 per cent. or more to have any decided antiseptic value; however, upon the dry skin the very strong alcohol (absolute and 95 per cent.) has been found less efficient than if it is diluted somewhat. This is due to the hardening effect of the undiluted alcohol which hinders penetration.

The experiments of Harrington and Harris* as to the germicidal power of alcohol in different strengths led to the following results:

"1. Against dry bacteria, absolute alcohol and ordinary commercial alcohol are wholly devoid of bactericidal power, even with twenty-four hours' direct contact; and other preparations of alcohol containing more than 70 per cent., by volume, are weak in this regard, according to their content of alcohol; the stronger in alcohol, the weaker in action.

"2. Against the commoner, non-sporing, pathogenic bacteria in a moist condition, any strength of alcohol above 40 per cent., by volume, is effective within five minutes, and certain preparations within one minute.

"3. Alcohol of less than 40 per cent. strength is too slow in action or too uncertain in results against pathogenic bacteria, whether moist or dry.

"4. The most effective dilutions of alcohol against the strongly resisting (non-sporing) bacteria, such as the pus organisms, in the dry state, are those containing from 60 per cent. to 70 per cent. by volume, which strengths are equally efficient against the same organisms in the moist condition.

"5. Unless the bacterial envelope contains a certain amount of moisture, it is impervious to strong alcohol; but dried bacteria, when brought into contact with dilute alcohol containing from 30 per cent. to 60 per cent. of water by volume, will absorb the necessary amount of water therefrom very quickly, and then the alcohol itself can reach the cell protoplasm and destroy it.

"6. The stronger preparations of alcohol possess no advantage over the 60 per cent. to 70 per cent. preparations, even when the bacteria are moist; therefore, and since they are inert against dry bacteria, they should not be employed at all as a means of securing an aseptic condition of the skin."

Certain of the vegetable tinctures have a reputation as antiseptics, which with a few is well-founded. When we consider the value of the contained alcohol, it appears that any addition of a drug that has antiseptic power should produce a valuable preparation.

Tinctura Myrrhæ.—Tincture of Myrrh.—Average dose, ♏ 15 (1 mil.).—This has long been used as an application to the gums, and as an ingredient in mouth washes. To irritated, lacerated or spongy gums, ulcers, etc., it may be applied freely. It cannot be diluted with water,

* Boston Medical and Surgical Journal, May 21, 1903.

for the latter precipitates the resinous portion of myrrh. It can only be mixed with water or aqueous solutions in the presence of a large percentage of alcohol. A dilution of alcohol with more than one-third water will not mix with tincture of myrrh without precipitation occurring.

Tinctura Benzoini.—TINCTURE OF BENZOIN (20 per cent.).—Average dose, ♏ 15 (1 mil.)

Tinctura Benzoini Composita.*—COMPOUND TINCTURE OF BENZOIN (10 per cent. benzoin). Average dose, ♏ 30 (2 mils.).

Benzoin contains resin, benzoic acid (about 14 per cent.) and traces of a volatile oil. Benzoic acid has been found, by a number of observers, to rank among our very best non-irritating antiseptics, and it is freely soluble in alcohol; therefore, these tinctures should be valuable antiseptics, as they contain 1 to 4 per cent. of benzoic and cinnamic acids, the latter being also valuable.

The compound tincture is a time-honored preparation, and one of the best antiseptic and stimulant applications to mucous membranes. An unhealthy or ulcerated condition of the gums calls for its use. It must be applied upon cotton. It cannot be used in a mouth wash because of the precipitation of the resin when mixed with water. Except the resinous portion, it may be vaporized with steam by being poured upon boiling water, and it thus forms a useful inhalant in irritable or infected conditions of the upper air passages. A useful prescription for this purpose is the following:

	Gm. or mil.	
℞—Phenolis liquefacti	10	(f℥ijss
Spiritus camphoræ	10	(f℥ijss)
Tincturæ benzoini compositæ	30	(f℥j)
Glycerini q. s. ad	60	(f℥ij)—M.

Sig.—A teaspoonful to a pint of boiling water. Inhale the steam.

For the correction of foul breath, when due to an unhealthy condition of tonsils or upper air passages, the same inhalation is useful; in addition the compound tincture may be applied in full strength to the surface of the tonsil and within all of its crypts that are visible. Foul breath may be due to the collection of solid offensive secretion within these crypts. This should be removed before making the application.

* The formula of compound tincture of benzoin contains:

Benzoin	100 parts
Purified aloes	20 "
Storax	80 "
Balsam of tolu	40 "
Alcohol, to make	1000 "

Balsamum Peruvianum.—BALSAM OF PERU.—A balsam obtained from *Toluifera Pereiræ.*—It is a thick, dark brown liquid, having an agreeable odor resembling that of vanilla. It is soluble in alcohol and in chloroform, partly soluble in ether and almost insoluble in water. Its value as an antiseptic depends upon benzoic and cinnamic acids and aromatics which it contains. It is rarely used internally, but is an agreeable and valuable application to ulcers and in parasitic diseases of the skin.

Acidum Benzoicum.—BENZOIC ACID [$C_7H_6O_2$].—Average dose, gr. 8 (0.5 gm.). An organic acid obtained from benzoin, or prepared artificially. This drug occurs in whitish crystals, with or without the odor of benzoin,* has a pungent taste and is somewhat volatile. It is soluble in 275 parts of water, but with an equal quantity of borax it is soluble in 100 parts of water; soluble also in 2.3 parts of alcohol and in 10 parts of glycerin. It has an *acid* reaction. A solution of 1 to 400 has been found to destroy developed bacteria; and according to Miller, a 1 per cent. solution will accomplish ordinary disinfection of the mouth in one-quarter of a minute. With its solubility in water increased by borax, the two may be combined in aqueous solution to make a very efficient mouth wash. It is found that a saturated solution of borax will dissolve 1 per cent. or more of benzoic acid and still be alkaline.

Incompatibility.—When a solution of benzoic acid has been neutralized by an alkali, as with borax, a precipitate will occur when mixed with *hydrochloric* or dilute *nitric* acid, or with dilute solutions of *ferric salts* or with *lead acetate*, *mercuric chloride* or *silver nitrate*.

Acidum Salicylicum.—SALICYLIC ACID [$C_7H_6O_3$].—Average dose, gr. 12 (0.75 gm.). An organic acid obtained from vegetable sources or prepared from carbolic acid. It occurs in very fine, white needles or crystalline powder, having a sweetish taste. It is soluble in 460 parts of water and in 2.7 parts of alcohol, 2 parts of olive oil and 60 parts of glycerin. It is *acid* in reaction. According to Miller,† a 1 per cent. solution will accomplish ordinary disinfection of the mouth in one-quarter of a minute. It must be ranked among our best antiseptics, but it is objectionable for continued use because of its *acid* reaction. The saturated aqueous solution is rather weak to be of much value as

* Benzoic acid prepared artificially does not have the odor of benzoin.

† Microörganisms of the Human Mouth.

a disinfectant; but a saturated solution of borax in water will dissolve 1 per cent. or more of salicylic acid and still be alkaline in reaction. Such a solution really makes an ideal mouth wash. The drug may also be used as a mouth wash either in combination with other antiseptics or in alcoholic solution diluted.

Incompatibility.—With *potassium chlorate, hydrochloric acid, nitric acid, chlorine* or a solution of *ferric chloride,* it undergoes chemical change. It causes gradual decolorization of a solution of *potassium permanganate.* With *carbonates* it effervesces, with the formation of salicylates.

Sodii Salicylas.—SALICYLATE OF SODIUM [$NaC_7H_5O_3$].—Average dose, gr. 15 (1 gm.). This salt is much more soluble in water than is the acid, being soluble in 0.9 part, also in 9.2 parts of alcohol and in glycerin. For internal use it is less disturbing to the stomach than salicylic acid, and it is used largely in the acute stage of rheumatism to control the fever and pain. It is not a very efficient antiseptic.

Phenylis Salicylas.—SALOL [$C_{13}H_{10}O_3$].—Average dose, gr. 5 (0.3 gm.) It occurs in form of a white, crystalline powder, having a sweetish taste, almost insoluble in water, soluble in 6 parts of alcohol, and in ether, chloroform and oils. It melts at 42° C. (107.6° F.). Its use in dentistry depends upon the ease with which it can be fused, and the fact that, when fused at a temperature considerably above its melting-point, recrystallization is retarded. Mascort* in 1894 advocated its use in melted form as a root-canal filling. Being a feeble antiseptic unless decomposed, its ready adaptability and non-irritating character must be its chief recommendations. It is used either alone or in connection with a cone of gutta-percha. This substance is not often employed as a local antiseptic, because of its insolubility in water. It may, however, be used in alcoholic solution. Its chief use is as an intestinal antiseptic. Its adaptability to this use lies in the fact that, passing through the stomach unchanged, it is first decomposed into carbolic and salicylic acids by contact with the alkaline juices in the small intestine, where the effect of these two antiseptic substances is then obtained. It is valuable in diarrheas and intestinal fermentation, but with large doses toxic effects of phenol are possible.

* Dental Cosmos, 1894, p. 352.

VOLATILE OIL GROUP.

Volatile oils are odorous, volatile principles, not possessing the chemical qualities of true oils. Since they are mostly obtained by distillation they are also called **distilled oils**; and, as they are usually the most essential constituent of the drug yielding them, they are also known as **essential oils.** While usually of vegetable origin, several are now made synthetically.

Volatile oils are colorless or nearly so when freshly distilled, becoming, as a class, somewhat colored with age and exposure, without losing any of their valuable properties. They are insoluble in water, soluble in alcohol, ether, chloroform and fixed oils. The volatile oils as a class are **antiseptics.** Some have an analgesic effect when applied to sensitive tissue, while others are irritating and a few are poisonous. Some are not applicable to uses about the mouth because of unpleasant taste or odor. Most of them are used in full strength as disinfectants in root canals and in carious cavities, but by prolonged use they may discolor the tooth structure.

Even with pulp exposure the non-irritating oils may be used. They do not destroy tissue, they do *not coagulate* albumin, hence they penetrate well, and any irritation from brief application is but slight and momentary. Exception to the last statement is found with oils of turpentine and mustard, but these are seldom used in the mouth because of their rank odor.

Dr. A. H. Peck* has contributed some excellent experimental work with the volatile oils and a few other antiseptics, in which he studied their antiseptic power, their action upon soft tissues, their influence upon the healing of sores and their germicidal action upon infected sores. He very properly holds that the volatile oils and other agents have been used "without reference to their relative merits as antiseptics, or to their therapeutic effects upon the tissues to which they are applied."

From these observations, a summary of which is given in the table following, he concludes that the oils of cinnamon (including oil of cassia), while high in antiseptic value, are too irritating to be used in root canals. Also that oil of cloves and creosote are superior agents, both being efficient antiseptics, while non-irritating to soft tissues. In fact, he found oil of cloves to possess local analgesic properties to a

* The Dental Review, August, 1898, p. 593.

marked degree. He regards oil of gaultheria as useless. Formalin he discards in the treatment of conditions about the mouth.

Attention is asked to the comparative table below, following which the several volatile oils are described separately:

Antiseptic Power and Local Action of Certain Volatile Oils and Other Substances (Dr. A. H. Peck).*

Antiseptic Power.			Action on Soft Tissues.	
10 c.c. of sterile mutton bouillon as culture medium. Growth of mouth bacteria prevented by amounts given below in drops. (Ratio varies as size of drop.)		Ratio.	When confined to skin by rubber cap.	When sprayed upon artificial sore (guinea-pig).
Oil of cassia......	0.3 drop, or	1:2233	24 hrs. Blister; intense inflammation with slow healing.	Healing prevented.
Oil of cinnamon (Ceylon).......	0.3 "	1:2100	24 hrs. Blister; less severe than above.	Healing prevented.
Oil of cinnamon (synthetic).....	0.3 "	1:2133	15 hrs. Blister; but no inflammation.	
Creosote (beechwood).........	0.5 "	1:1280	36 hrs. No irritation.	Sore healed.
Oil of cloves......	0.6 "	1:1150	36 hrs. No irritation.	Rapid healing.
Oil of bay........	0.7 "	1:1028	36 hrs. No irritation.	Inflammation subsided gradually.
Oil of sassafras....	0.7 "	1:1000	36 hrs. No irritation.	Inflammation subsided.
Oil of peppermint.	0.8 "	1:875	36 hrs. No irritation.	Inflammation subsided.
Black's "1-2-3"†..	1.4 drops, or	1:454	36 hrs. No irritation.	Inflammation subsided.
Phenol (95%)....	1.8 "	1:338‡		
Oil of cajuput....	6 "	1:120	36 hrs. No irritation.	No irritation.
Eucalyptol (Sander's and Merck's	6 "	1:116	36 hrs. No irritation.	Inflammation subsided.
Eucalyptol (ordinary)......	Saturated solution required.			
Oil of gaultheria. Eugenol	No action even in saturated solution (8 drops).			
Formalin.........	0.4 drop, or	1:1400	4 hrs. Severe pain. 20 hrs. Severe inflammation, followed by sloughing and toxic symptoms.	

Germicidal Action. Applied to infected sores, pus germs were destroyed by the cinnamon oils, creosote, oil of cloves, oil of bay, oil of peppermint and Black's "1–2–3." Oil of sassafras was less efficient, while the action of oil of cajuput and eucalyptol was not very positive.

* For article forming basis of this summary, see Dental Review, August, 1898.

† Black's "1–2–3" mixture (mild) consists of 1 part oil of cassia, 2 parts phenol (crystals), and 3 parts oil of gaultheria.

‡ The influence of phenol was transient, growth occurring after three days.

Oleum Cassiæ.—Oil of Cinnamon.—Oil of Cassia.—Average dose, ♏ 3 (0.2 mil.). A volatile oil distilled from Cassia cinnamon (young twigs), containing not less than 80 per cent. of *cinnamic aldehyde*, and having the odor and taste of cinnamon. It is yellowish or brownish in color, becoming darker and thicker by age and exposure; sp. gr. about 1.055; soluble in about 3 parts of 70 per cent. alcohol. The changes by age are due to the oxidation of cinnamic aldehyde to cinnamic acid and resins; therefore, the oil should be kept from exposure to light and air in well-stoppered, amber-colored bottles, in a cool place. The oil is frequently adulterated.*

Oil of cinnamon is *non-coagulant* to tissues, it is penetrating, it is agreeable in odor and the discomfort of its application to soft tissues is momentary, unless it is confined for some time, when it may cause severe irritation. It is doubtless the most powerful antiseptic of all the volatile oils used in dentistry (see preceding table). It is used for tooth disinfection, but is less applicable to front teeth than to posterior ones, because of its discoloring effect with continued use, this being due to its tendency to become darker with exposure. It may be used in full strength in pyorrhea with deep pockets.

Aquæ Cinnamomi.—Cinnamon Water.—Average dose, f℥ 4 (15 mils.). Cinnamon water is officially prepared as follows:

		Gm. or mils.
℞—Olei cassiæ		2
Talci purificati		15
Aquæ destillatæ	q. s. ad	1000

Triturate the oil with the purified talc, add the recently boiled distilled water gradually with continued trituration, filter, and pass the filtrate through the filter repeatedly until the cinnamon water is perfectly clear. (It is estimated that one-half of the oil is dissolved by the water.)

Spiritus Cinnamomi (10 per cent.) is also official. Average dose, ♏ 30 (2 mils.).

The official cinnamon water is useful as a mouth wash and to irrigate fistulous tracts, as, according to Dr. Peck's report, it should be able to prevent the growth of mouth bacteria. It is very pleasant to the taste and can well be used in preference to proprietary liquids of complex composition and uncertain value. It may be used in full strength freely.

Oil of cinnamon is an important ingredient in the formula of Dr.

* Oil of cassia has often been found adulterated with a mixture of petroleum and rosin. The U. S. P. test for detection is as follows: Shake 2 mils. of the oil in a test-tube with from 5 to 10 mils. of purified benzin, and decant the latter; this liquid is colorless and does not assume a green color upon shaking it with an equal volume of $\frac{1}{10}$ per cent. copper acetate solution.

Black, known as Black's 1–2–3, which is widely used as a dressing in pulp canals where antiseptic and anodyne action is needed. The formula is as follows:

	Gm. or mils.
℞—Olei cassiæ	4
Phenolis (crystals)	8
Olei gaultheriæ	12

Mix the oils and add the melted crystals of phenol.

CINNAMIC ALDEHYDE [C_9H_8O] (not official).—An aldehyde obtained from oil of cinnamon or prepared synthetically. It should be 95 per cent. in strength. It is nearly identical with the official oil of cinnamon, having the same qualities in general, but being more definite in composition. At a low temperature it becomes solid, melting again at 18.5° F. It is sparingly soluble in water, but soluble in alcohol, ether and oils. It uses are the same as those of oil of cinnamon.

Oleum Caryophylli.—OIL OF CLOVES.—Average dose, ♏ 3 (0.2 mil.). A volatile oil distilled from cloves (the flower-buds of *Eugenia Aromatica*), varying in color from pale yellow to brown, age and exposure producing the change. It has the odor and taste of cloves, is soluble in 2 parts of 70 per cent. alcohol, the resulting solution having a slightly acid reaction. Sp. gr. about 1.050. Its chief constituent of value is *eugenol*, of which it should contain 82 per cent.

While the change in color does not impair its value, it should be kept protected from light and air, so as to retard the same.

Oil of cloves has a high antiseptic value (1 to 1150 for mouth bacteria), while Dr. Peck's experiments have proved positively that it is not only non-irritating locally, but that, when applied to inflamed or infected tissues, it is decidedly soothing, and healing progresses rapidly under its application. It is *non-coagulant* to tissue.

It can be used freely as a tooth and root canal disinfectant, though its tendency to discolor prohibits its use in front teeth. It is entitled to a larger use as an application to irritated and infected tissues. In addition to its dental uses, oil of cloves is employed in the preparation of microscopic specimens.

Eugenol [$C_{10}H_{12}O_2$].—Average dose ♏ 3 (0.2 mil.). An aromatic phenol, the chief constituent of oil of cloves, but obtainable also from other sources. Sp. gr. about 1.067. It is similar to oil of cloves in all of its qualities. It may be mixed with alcohol in any proportion and it is soluble in 2 parts of 70 per cent. alcohol. In Peck's observations it was found to be much inferior to oil of cloves (*vide ante*).

The two following agents are very similar, both owing their value chiefly to *cineol* (identical with cajuputol and eucalyptol).

Oleum Cajuputi.—Oil of Cajuput.—Average dose, ♏ 8 (0.5 mil.). A volatile oil obtained from the fresh leaves and twigs of *Melaleuca leucadendron*. Its chief constituent is *cineol* (eucalyptol), of which there should be at least 55 per cent.

It is a light, thin, colorless liquid, with an aromatic odor and taste. It is soluble in 1 part of 80 per cent. alcohol, the solution being neutral. Sp. gr. about 0.920.

Oleum Eucalypti.—Oil of Eucalyptus.—Average dose, ♏ 8 (0.5 mil.). Distilled from the fresh leaves of *Eucalyptus globulus*, this volatile oil owes its value to *cineol* (eucalyptol), of which it should contain 70 per cent. It is soluble in 4 parts of 70 per cent. alcohol, the solution being neutral. Sp. gr. about 0.915.

It is similar to oil of cajuput because of the presence of cineol. It has no distinct value in comparison with other volatile oils, and preference is usually given to the following chief constituent, which is more definite than the oil.

Eucalyptol.—Cineol.—Cajuputol [$C_{10}H_{18}O$].—Average dose ♏ 5 (0.3 mil.). An organic compound obtained from oil of eucalyptus and other sources. It is a colorless liquid with an aromatic, camphoraceous odor and a spicy, cooling taste. It is soluble in alcohol in any proportion, the solution being neutral. Sp. gr. 0.922. It should be kept protected from air and light.

Eucalyptol has no special advantage over the stronger volatile oils, though regarded by some as especially detergent in root canals. It is non-irritating and non-coagulant. Its antiseptic value is shown in the table on p. 137.

Oleum Gaultheriæ.—Oil of Wintergreen.—[Known now officially as **Methylis Salicylas.**—Methyl Salicylate] [$CH_3C_7H_5O_3$].—Average dose, ♏ 12 (0.75 mil.). This volatile oil is produced synthetically or distilled from *Gautheria procumbens*. From either source, it has the odor and taste of wintergreen. It is used chiefly as a flavoring agent Its antiseptic value is low.

Thymol [$C_{10}H_{14}O$].—A phenol, present in the volatile oil of *Thymus vulgaris* and some other volatile oils. Dose, gr. 1–30 (0.06–2 gm.). It occurs in large, colorless crystals, having a penetrating odor of thyme and an aromatic taste, soluble in 1010 parts of water, in about 1 part of alcohol, also soluble in chloroform, ether and oils. It is used as a general antiseptic, having a germicidal power similar to that of phenol, as a

substitute for which it was introduced into medicine. It is less toxic than phenol. It is used also as an anthelmintic, being regarded almost a specific in hook-worm disease (uncinariasis) where it is given in the large dosage of from 1 to 2 gms. per day.

Thymolis Iodidum.—Thymol Iodide [$C_{20}H_{24}O_2I_2$].—This substance, known also as *Aristol,* contains 43 per cent. of iodine. It is a reddish-yellow or brownish powder, insoluble in water and glycerin, very slightly soluble in alcohol, freely soluble in ether and in oils. It does not keep well unless protected from light. It is used as an antiseptic powder, and is applicable as a pulp-canal dressing.

Oleum Menthæ Piperitæ.—Oil of Peppermint.—Average dose, ♏ 3 (0.2 mil.). A volatile oil distilled from the flowering plant of *Mentha piperita,* yielding 50 per cent. of total menthol (5 per cent. as esters). It is colorless, neutral and soluble in 4 parts of 70 per cent. alcohol. It should be kept in a cool place and protected from light. It possesses a strong odor of peppermint. Its contact with tissue is followed by a sensation of cold. In form of the spirit (10 per cent.) it is given internally as a carminative. Locally it is analgesic and antiseptic, and is, therefore, useful to relieve itching of skin or mucous membrane, a 5 to 10 per cent. ointment or solution in alcohol being used.

Menthol [$C_{10}H_{19}OH$].—Average dose, gr. 1 (0.06 gm.). A secondary alcohol obtained from oil of peppermint or other mint oils. It occurs in colorless crystals having the characteristic odor of peppermint. It is only slightly soluble in water, freely soluble in alcohol, ether, chloroform and oils. When rubbed upon the skin there follows a decided sensation of cold to the part. This effect classes it as an analgesic and makes it a valuable application in itching (pruritus) of various parts. It may be applied in solution or in ointment.

It is a useful antiseptic for internal administration and for local dental uses. As an analgesic antiseptic for use in pulp treatment it may be dissolved in chloroform or in a volatile oil. In neuralgias and headaches the solid crystal is rubbed upon the skin of the painful area.

Oleum Terebinthinæ Rectificatum.—Rectified Oil of Turpentine.—Average dose, ♏ 5 (0.3 mil.). This agent has been discussed in its more important use as an irritant. As an antiseptic it is chiefly used externally to disinfect the skin or the hands of the operator in preparation for surgical operations.

Terebenum.—Terebene.—Average dose, ♏ 4 (0.25 mil.). The reaction between oil of turpentine and sulphuric acid yields a colorless liquid, known as terebene. It has an agreeable odor and aromatic

taste, and it should rank among the valuable antiseptics for local use. It is almost insoluble in water, but is soluble in 3 parts of alcohol. With exposure to light and air it gradually becomes resinified and acquires an acid reaction. It is used internally in bronchitis.

HALOGEN GROUP.

Bromum.—Bromine [Br].—Besides its use as an escharotic, bromine in aqueous solution (soluble in 90 parts) is a good general disinfectant, but its irritating vapor precludes its use about the mouth or air passages.

Chlorine [Cl].—(For internal doses, see Index of Drugs.) Pure chlorine in gaseous form is too irritating and poisonous to be employed except to disinfect rooms. One part in 100 of the atmosphere, with moisture present, is an efficient germicide for disinfection of dwellings. In either of the official preparations it is available for tooth disinfection or bleaching. It is also a deodorant by its power of decomposing sulphuretted hydrogen compounds. Its disagreeable odor is an objection to its use as a mouth-wash, but it is a very efficient antiseptic. Even 1 part in 22,000 has been found capable of killing developed bacteria.*

The value of chlorine as a water disinfectant has led to the method of "chlorination" upon a large scale in order to insure a safe water supply to cities. In the experience of the city of London it has been found that 1 part of chlorine to 2,000,000 parts of water is efficient, while 1 part in even 3,000,000 has given considerable success.†

Following are the commonly used chlorine disinfectants:

Liquor Sodæ Chlorinatæ (Labarraque's solution) contains at least 2.5 per cent. of available chlorine.

Calx Chlorinata (Chlorinated lime, Bleaching powder) contains at least 30 per cent. of available chlorine.

Incompatibility.—Chlorine gas with a solution of *ammonium chloride* forms chloride of nitrogen, which is explosive. Chlorine water decomposes *potassium iodide* in solution, liberating iodine, and mixed with a solution of *silver nitrate* it precipitates chloride of silver. In contact with *silver cyanide* it liberates hydrocyanic acid. It oxidizes *organic* substances and destroys vegetable colors. Liquor sodæ chlorinatæ is decomposed by *hydrochloric acid* with evolution of chlorine gas and carbon dioxide.

* Brunton's Pharmacology, 1885, p. 96.

† Houston: Water and Gas Review, New York, May, 1919.

Iodum.—IODINE [I].—This substance ranks with the other halogens as a powerful antiseptic. The tincture can be added to water to secure any desired strength, a weak solution being suitable as an irrigation to pus cavities. As an inhalant in pulmonary diseases, when a powerful antiseptic vapor is needed, the tincture may be vaporized with steam in a strength not to exceed 10 minims (0.6 gm.) to a pint of boiling water, usually combined with carbolic acid, eucalyptol or similar drugs. In its uses it has been considered under Irritants.

Iodoformum.—IODOFORM [CHI_3].—Obtained by the action of iodine upon alcohol in the presence of an alkali, it is in form of a lemon-yellow crystalline powder, with a very penetrating odor resembling that of iodine. It is practically insoluble in water, soluble in 60 parts of alcohol and in 7.5 parts of ether. It contains 96.7 per cent. of iodine, to which its antiseptic power has been supposed to be due. However, Heile* found that the value of iodoform does not depend upon nascent iodine, but upon a much more active substance, diiodacetylidin, which is set free from iodoform in contact with organic substances when air is excluded Iodoform differs from iodine in being non-irritant. As an antiseptic dressing it is applied in powder, or upon gauze, to wounds and ulcers. Its disagreeable odor precludes its use in dentistry; but a number of odorless or less unpleasant substitutes have been introduced, examples of which are here named, the first only being official. They are all nearly insoluble in water.

Thymol Iodide (Aristol), containing 43 per cent. of iodine.

Iodol containing 89 per cent. of iodine.

Antiseptol, containing 50 per cent. of iodine.

Losophane, containing 78 per cent. of iodine.

Sozoiodol (Sozoiodolic acid), containing 54 per cent. of iodine, 20 per cent. carbolic acid, and 7 per cent. sulphur. This substance has acid combining properties and forms a number of salts. Sodium sozoiodolate is preferred on account of its ready solubility in water and in glycerin.

In addition to the above group, the following substance, derived from coal-tar, holds a place as an antiseptic powder:

Acetanilidum [C_8H_9NO].—Acetanilid, a white crystalline substance, obtained by the interaction of glacial acetic acid and aniline, is employed in very fine powder, as an antiseptic, by being dusted upon wounds

* See Gould's Year-Book of Medicine, 1905, p. 498.

after surgical operations. Being only slightly soluble, it is an excellent substitute for iodoform. It is soluble in 190 parts of water and in 3.4 parts of alcohol.

MISCELLANEOUS ANTISEPTICS.

Among the following agents will be found none of the ready-made proprietary solutions or mixtures that are advertised so largely as antiseptics. Such are entitled to no place in a book that aims to treat subjects in a scientific way, for the basis of their exploitation is commercial, and their use should be regarded as unethical. But, aside from these considerations, there is evidence that they are inferior to some of our well-known simple agents. The only reason for a reference to such preparations here is in order to discourage their use, and this can be done upon the ground of their inefficiency, as shown below.

In a very important series of observations in the field of mouth disinfection, Wadsworth,* working in connection with the Health Department of New York City, presents a comparison of the antiseptic power of several of the most popular of the proprietary solutions with that of alcohol.

His observations were made with the pneumococcus, which is so frequently found in the mouth. He found that this bacterium can be readily destroyed in a broth culture, but that in sputum its destruction by harmless solutions is extremely difficult, for the reason that, with many antiseptics, diffusion into sputum or into an exudate is hindered by the albuminous matter. Alcohol proved to be very diffusive and this property was greatly aided by the addition of glycerin.

The observer's conclusions include the following statement: "Of all the commercial solutions studied—listerine, borine, borolyptol, glycothymoline, odol and Seiler's solution—none proved efficient when tested on pneumococci under the conditions *most favorable* for their action. Formalin, lysol and hydrogen peroxide failed to act upon the pneumococci in exudates. In short, alcohol alone, of all antiseptics studied, proved efficient when tested on the pneumococci *under all the conditions* of the experiments."

Alcohol was used in the strength of 20 to 40 per cent. Preference is given to a mixture of water, glycerin and 30 per cent. of alcohol, as being readily diffusible, efficient and harmless.

* Journal of Infectious Diseases, October, 1906.

Betanaphthol.—NAPHTHOL [$C_{10}H_7OH$].—A phenol occurring in coal-tar but usually prepared from naphthalin. It occurs in colorless or buff-colored crystals, having slight odor and sharp taste, soluble in 1000 parts of water and in 0.8 part of alcohol; soluble also in glycerin and in olive oil. It is *neutral.* Average dose, gr. 4 (0.25 gm.).

Betanaphthol in solution is useful to keep instruments sterile during an operation, as it does not corrode metals. It is applied as an antiseptic to tissues, from the 1 : 1000 saturated aqueous solution, which may be used to irrigate wounds and as a mouth wash freely, to the full-strength alcoholic solution (1 : 0.8) in the disinfection of root canals. Upon soft tissues, and as a cleansing and disinfecting agent in pyorrhea alveolaris, a 1 : 200 or 1 : 300 solution may be used, prepared either with alcohol or hot water, for it is soluble in 75 parts of boiling water. A saturated solution in hot water, allowed to cool to the desired point, is very useful; while some of the drug precipitates with cooling, the solution will be saturated at whatever temperature used.

Incompatibility.—With *chlorine* water or *bromine* water betanaphthol will produce a white turbidity.

Resorcinol.—RESORCIN [$C_6H_6O_2$].—A phenol from various sources. It occurs in colorless or pinkish crystals, having a sweetish taste, soluble in 0.9 part of either water or alcohol, also soluble in glycerin or ether. It is *neutral* or *slightly acid.* Average dose, gr. 2 (0.125 gm.). This drug is useful as a mouth antiseptic, a 2 per cent. solution in water being a proper strength for mouth wash or gargle. It is frequently employed in whooping-cough to cleanse the throat and posterior nares by instilling the 2 per cent. solution directly into the nostrils several times daily. Although similar to phenol in action and uses, it is not corrosive and is less dangerous. The internal dose being double that of phenol, it can be used in stronger solution (2 to 5 per cent.) for general antiseptic purposes.

Incompatibility.—The aqueous solution of resorcin will react with *chlorinated lime, ferric chloride* or *bromine* water.

Potassii Chloras.—CHLORATE OF POTASSIUM [$KClO_3$].—It occurs in colorless crystals or white powder, odorless, and having a salty taste. It is *neutral,* soluble in 11.5 parts of water, soluble also in glycerin, but almost insoluble in alcohol. Average dose, gr. 4 (0.25 gm.).

The U. S. P. advises caution with this salt, as explosion may occur when it is mixed with organic matter (tannic acid, sugar, etc.), or with sulphur, sulphides, hypophosphites or other easily oxidizable substances.

It is not a strong antiseptic, a 3 per cent. solution failing to prevent

the development of bacteria. In mercurial or other forms of stomatitis it is used in saturated solution as a mouth-wash, or in tablet form it is allowed to dissolve slowly in the mouth. It is also valued highly by some as an internal remedy in aphthous stomatitis. It has become a popular remedy in sore-throat, undeservedly so, and is bought and used too freely. Great care must be exercised in the internal use of this drug and its indiscriminate sale should be discouraged, because of its poisonous effects in the blood. It can change hemoglobin into methemoglobin, and in large doses it may also irritate the kidneys.* On the whole, it must be said that the usefulness of potassium chlorate has been overrated and its dangers not sufficiently recognized.

Incompatibility.—Besides the dangers mentioned above, the drug is incompatible with *strong sulphuric* and *hydrochloric acids.* (A drop of *sulphuric acid* will ignite a mixture of equal parts of potassium chlorate and *sugar.*) An aqueous solution mixed with *silver nitrate* will precipitate silver chloride.

Potassii Permanganas.—PERMANGANATE OF POTASSIUM [$KMnO_4$].—It occurs in dark purple crystals, having a characteristic, unpleasant taste: *neutral;* soluble in 13.5 parts of water. Its aqueous solution is rose-colored when dilute and deep purple when concentrated. It decomposes in contact with alcohol. Being a powerful oxidizing agent the U. S. P. directs that it should be kept in glass-stoppered bottles, protected from light, and should not be brought in contact with organic or readily oxidizable substances. Average dose, gr. 1 (0.06 gm.).

Its oxidizing power makes it a valuable disinfectant and deodorant. Applied to the mucous membrane of the mouth in proper dilution it is non-irritant, but it produces a dirty brown stain, which is an objection to its use. However, the stain is easily removed from accessible surfaces by a solution of oxalic acid. It may be applied locally in any strength up to, or even above, 5 per cent. Its action is quite superficial and is to be explained by the fact of the liberation of oxygen, which unites with the albumin of the tissues. Very strong solutions, therefore, may be irritating and even somewhat caustic to mucous

* As examples of fatal poisoning by potassium chlorate note the following: (1) A woman, aged seventy years, took 1 ounce by mistake for Epsom salt. Four hours later she fainted, became cyanosed and died fifteen hours after taking. (2) An infant of three weeks died in three days from about 1 gm. (gr. 15), which had been dusted into its mouth. Of 89 cases recorded, 76 were fatal. Witthaus and Becker, Med. Jurisprudence, 1896, vol. iv.

membranes. It has been found efficient, and has been extensively used by surgeons, as a hand disinfectant in preparation for operating. After preliminary scrubbing of the hands and nails with soap and water, they are immersed in a saturated aqueous solution of the permanganate. This is followed by a solution of oxalic acid which removes the stain of the permanganate.

When used as a mouth wash, 1 : 1000 is a proper dilution. Its use within a carious cavity is always to be avoided; other agents are just as efficient, without the objectionable staining quality. As an application to the throat in diphtheria or tonsillar infection, and to foul ulcers, it possesses considerable value. In 1 per cent. solution it has been found to destroy developed bacteria and in 1 : 1000 it prevents their development.* It is an efficient chemical antidote to morphine if given while the latter is still in the stomach, and, since morphine is partly eliminated into the stomach, in prolonged cases of poisoning the stomach may be washed out at hourly intervals with a weak solution (1 : 2000).

Incompatibility.—With *organic* substances, or triturated with *sulphur* or other inflammable substances, explosion may occur. For this reason it should not be mixed in a closed vessel with *syrup* or *glycerin*. With *carbolic acid* oxidation occurs. *Alcohol, oxalic acid* or solution of *hydrogen dioxide* will decompose it.

This drug should be used alone in a simple aqueous solution.

Sodii Thiosulphas.—THIOSULPHATE OF SODIUM.—*Hyposulphite of Sodium* [$Na_2S_2O_3 + 5H_2O$].—This salt is soluble in 0.5 part of water and the solution is *neutral;* insoluble in alcohol. Its antiseptic power makes it a useful mouth wash. It is also a useful internal antiseptic. Average dose, gr. 15 (1 gm.).

Zinci Chloridum.—CHLORIDE OF ZINC.—(For general properties, see under Escharotics.) This substance, on account of its germicidal and penetrating power, must be ranked among our best antiseptics. The disadvantages in its use are the irritation it causes and its coagulant action. For tooth disinfection, especially in pulpless teeth, these disadvantages do not obtain, and strong solutions (above 20 per cent.) may be used; while for mouth disinfection a 1 per cent. solution may be employed. It must be remembered that its coagulation of albuminous matter liberates hydrochloric acid, which should not remain

* Brunton's Pharmacology, 1885, p. 96.

about the teeth, but must be neutralized at once. The following formula is typical:

		Gm. or mil.	
℞—Zinci chloridi		2|4	(gr. xxxvij)
Glycerini		30|0	(f℥j)
Aquæ rosæ	q. s. ad	240|0	(f℥viij)

M. et Sig.—Use as a mouth wash.

Argenti Nitras.—NITRATE OF SILVER [$AgNO_3$].—(For solubility and properties, see under Escharotics.) Although generally inadmissible as a mouth or tooth antiseptic because of its staining quality, this drug is valuable in severe local infections of the mucous membrane. It is destructive to the gonococcus wherever found, and in that severe form of conjunctivitis known as ophthalmia neonatorum, which is usually a gonorrheal infection of the eyes occurring during birth, nitrate of silver is most relied upon as the germicide. Also, in order to prevent this serious malady, the advice of Credé* should be supported and followed, which is, that the eyes of all babes born in charitable institutions should invariably have a 2 per cent.† solution of silver nitrate instilled into them immediately after birth, so as to disinfect every part of the conjunctival membrane. As evidence of the efficacy of such preventive treatment, it may be noted that the statistics of large lying-in institutions where it has been employed, show that the Credé method has reduced the disease to less than one-fifteenth of its former prevalence in the same institutions. Whenever nitrate of silver is locally applied, any excess may be completely neutralized by a solution of sodium chloride. Stains of silver nitrate may be removed by a solution of potassium cyanide (not applicable within the mouth as the cyanide is very poisonous), or by moistening with a solution of iodine followed by sodium thiosulphate.

Certain other preparations of silver have been found to be highly antiseptic and have come into use in general surgery. Of these the most remarkable is an allotropic form of *metallic silver that is soluble* in water and in albuminous fluids. The aqueous solution of this (usually 1 per cent.) may be injected into infected tissues, and has

* The justification for this advice is found in the large percentage of cases of blindness that are due to this severe inflammation, occurring as a result of infection of the eyes at birth. In 1897 an investigation of the causes of blindness of the 306 inmates of the schools for the blind in New York State showed that 21 per cent. of cases were due to ophthalmia neonatorum. Howe, Transactions of the Medical Society of the State of New York, 1897.

† A 1 per cent. solution is now commonly used.

even been used intravenously in cases of septicemia. It is also used in form of ointment rubbed into the skin. The following non-official preparations are also now employed in general surgery:

Silver Lactate.—Actol [$AgC_3H_5O_3 + H_2O$].—This occurs in colorless crystals, easily affected by light, soluble in 15 parts of water. An aqueous solution of 1 : 1000 may be used, as 1 : 300 to 1 : 500 solution is said to be equivalent to 1 : 1000 mercuric chloride solution in disinfectant power.*

Silver Citrate.—Itrol [$C_6H_5O_7Ag_3$].—A white powder, soluble in 3800 parts of water, said to be destructive to all ordinary germs when used in a solution of 1 : 4000. The solution should be freshly prepared. It is also used in ointment of 1 to 2 per cent. strength.

Protargol (*Protein Silver*).—This substance is a silver albumose, containing 8 per cent. of metallic silver. It is a yellowish powder, readily soluble in water, and is less irritating than nitrate of silver. The reason for this probably is that, being an albumin compound, its application to tissues is not followed by the liberation of an acid, as is the case with the nitrate. It destroys various bacteria, and it has, therefore, come to be used much as a substitute for the nitrate in purulent inflammations of mucous membranes, particularly when they are gonorrheal in nature. One to 5 per cent. is the strength of solution in which it is employed. As to germicidal power, Post and Nicoll found a 10 per cent. solution about equivalent to 1 : 5000 solution of silver nitrate.†

Argyrol (*Silver vitellin*).—A proteid salt of silver occurring in black scales, containing 30 per cent. of metallic silver. It is freely soluble in water and the solutions do not readily deteriorate. It does *not coagulate* albumin nor precipitate chlorides. It is comparatively non-irritating and non-toxic, therefore, it may be used freely even in strong solution, *e. g.*, in simple conjunctivitis 5 to 20 per cent. may be applied several times daily and in the gonorrheal form 25 to 50 per cent. As an irrigating fluid 1 : 1000 may be freely used and internally 5 to 10 grains may be given. Its antiseptic power is small as compared with silver nitrate. Post and Nicoll found a 50 per cent. solution inferior to a 1 : 10,000 solution of silver nitrate in germicidal power.‡ Stains of argyrol may be removed by a 1 : 500 solution of mercuric chloride.

Preparations of silver have been used internally, especially the nitrate and oxide, for alterative effect. It must be noted that the prolonged internal use of this metal should be discouraged. It is

* National Dispensatory, 1916.

† Wood's Pharmacology and Therapeutics, 1916, 2d ed. ‡ Ibid.

capable of producing a permanent staining of tissues, which is outwardly shown by a slight blueness of the skin. This condition is known as *argyria* and is due to the deposit of silver in the papillary layer of the skin. The same condition may be produced in a smaller area by the local use of silver preparations, where they are allowed to enter the tissues.

Hydrargyri Chloridum Corrosivum.—MERCURIC CHLORIDE.—*Bichloride of Mercury.—Corrosive Sublimate.—Perchloride of Mercury* [$HgCl_2$].—Average dose, gr. $\frac{1}{20}$ (0.003 gm.) This substance occurs in colorless, odorless crystals, having a disagreeable metallic taste, soluble in 13.5 parts of water, in 3.8 parts of alcohol, and in about 12 parts of glycerin. It is *acid* in reaction, although the addition of chloride of sodium to its aqueous solution will render it neutral. Because of its corrosive properties, for *general* antiseptic purposes it is used only in dilute solution of 1 : 2000 to 1 : 10,000. However, for *limited* use as a powerful disinfectant, it may be used as strong as 1 : 1000 or even 1 : 500 in the mouth, as in plantation cases.

This drug may cause poisoning in two ways, either as a corrosive by local destruction of tissues, or, after absorption, as a systemic poison. In the former case a strong solution or the pure salt is necessary to cause poisoning, while in the latter case small doses continued, or careless use of ordinary solutions or of any preparation of mercury, is likely to cause systemic mercurial poisoning, with the production of salivation. For example, a single cathartic dose of calomel, or the daily use of the compound cathartic pills, which contain 1 grain of calomel each, has caused salivation.

This powerful drug will seldom be the antiseptic of first choice in dental practice. Its unpleasant, metallic taste prevents its use as a mouth-wash. As a tooth disinfectant it is seldom used because of the danger of staining the tooth through the formation of sulphide of mercury.* It corrodes instruments, therefore cannot be used to sterilize them, although glassware may be easily sterilized by the solution of 1 : 1000.

In spite of all disadvantages mercuric chloride remains as one of the most efficient germicides. In general medicine and surgery the weaker solutions (1 : 3000 to 1 : 10,000) are used cautiously and for a short time, to irrigate wounds and abscess cavities, to disinfect ulcers, and as douches into the several passages of the body. Whenever used, a

* See remarks on metallic stains in Kirk's article on "Discolored Teeth and their Treatment," American Text-book of Operative Dentistry, second edition, page 559.

free escape of the solution must be insured, and its use in these ways should rather be regarded as a temporary necessity, to be supplanted by safer agents. As a rule, it should not be combined with other substances.

Incompatibility.—Mercuric chloride mixed with *lime-water, ammonia* or *carbonates* of the alkalies, will produce a precipitate. With a solution of *soap* a precipitate of mercurial soap occurs. With *potassium iodide* red iodide of mercury is formed. *Hydrogen sulphide* causes a black precipitate of mercuric sulphide. With *silver nitrate* a deposit of *chloride of silver* occurs. *Metals* are tarnished by it, amalgamation occurring with silver and some others. *Albumin* is coagulated by it.

Acute Poisoning.—The symptoms of acute poisoning by this drug are those produced by any corrosive irritant—*i. e.*, pain in the stomach, with vomiting and prostration. The chemical antidote is albumin. (See Table of Poisons and Antidotes.)

Systemic Poisoning or Mercurialism.—Only the soluble salts of mercury are capable of causing local irritation, but any preparation of this metal may cause mercurialism. The symptoms of this condition may come on without any gastric disturbance; in fact, it is fortunate that the first indications of systemic saturation occur in the mouth, where they are at once noticed and easily recognized; and the dentist should be familiar with the early symptoms of this, possibly disastrous, toxic disturbance.

The first symptom will be hyperemia of the more vascular structures, the pericementum and gums, causing in the former slight tenderness upon forcible closure of the jaws, and in the latter redness. If the condition progresses, the soreness of the teeth becomes decided and an increased flow of saliva occurs, with decided fetor of the breath. This gives the picture of salivation in a positive degree; fortunately the superlative degree, with ulceration and loss of teeth, is almost never seen today because of smaller quantities of the drug now given, with the decline of the antiphlogistic methods of treatment which were formerly in vogue. The elimination of mercury in the saliva, from a system saturated with it, is probably responsible for the occurrence of the ulcerative stomatitis seen in severe cases. Right here let it be stated that detection by the dentist of the early symptoms of mercurialism should call forth no reflection upon the physician who prescribed mercury. This for two reasons: (1) The condition may have occurred accidentally through idiosyncrasy—*i. e.*, a special susceptibility of the patient to the action of the drug, which is sometimes seen; or, the

patient may have exceeded directions and used the medicine carelessly. (2) The condition may be intentional, for, in the treatment of syphilis, the use of mercury in some form is often pushed to saturation for a time.

Treatment of Mercurialism.—The patient will complain of two symptoms if the condition is well developed: (1) soreness of the teeth, and (2) the constant flow of saliva which may interfere with sleeping. These will need to be relieved. Relief of the pericementitis and stomatitis must be brought about by elimination through other channels than the salivary and oral glands. The bowel being the most natural route for the elimination of mercury, saline cathartics, freely given, by their power of withdrawing serum from the blood, will serve our purpose best. The salivation may be controlled by belladonna or its alkaloid, atropine. Of the tincture give 5 minims (0.3 gm.), or of atropine gr. $\frac{1}{100}$ (0.0006 gm.) two or three times daily. This is the best drug for this purpose, as it checks the salivary secretion very decidedly and is not disturbing to the system if used properly. Opium, or morphine, also causes dryness of the mouth, but the systemic effects are unpleasant; and on the whole they are inferior to belladonna. A mouth wash of solution of potassium chlorate (2 to 4 per cent.) is often used in addition. Reports have also been made of the very successful use of hydrogen dioxide in this condition. One part of the official solution to 3 of water, as a mouth wash every half hour, is recommended. Its peculiar detergent property makes it particularly applicable to severe cases, where ordinary antiseptics are less useful. With improvement in the condition, the saline cathartics should still be continued until the drug is believed to have been thoroughly eliminated. Potassium iodide has long been used to aid elimination of this as of other heavy metals. The dose is 10 to 30 grains (0.6–2 gm.) three times daily. It is believed to form the more soluble iodide, which then passes out through the kidneys.

Carbo Ligni.—Wood Charcoal.—Employed as deodorant.

Carbo Animalis.—Animal Charcoal (not official).—Prepared from bone; employed as a decolorizing agent in preparing organic solutions.

Carbo Animalis Purificatus.—Purified Animal Charcoal.—*Boneblack* (not official).—The purification consists in decalcifying by boiling for hours in hydrochloric acid diluted with water. It is employed as an antidote to organic poisons.

Charcoal of any kind is not really antiseptic, but it is deodorant and detergent and has marked absorbent power. Obviously its applica-

tion to mouth conditions is limited, though its general value should be appreciated.

Wood charcoal, prepared from soft wood because more porous, is least powerful of the group, but it has the power of absorbing gases to a large extent—*e. g.*, it is said to be capable of absorbing ninety times its own volume of ammonia gas. It destroys foul gases by absorbing and condensing them within its pores. This power may be increased by platinizing the charcoal.

In order to be an efficient deodorant, wood charcoal must either be fresh, or have been recently heated so as to destroy organic impurities that may have been taken up through exposure to the air.

Animal charcoal is a more powerful absorbent, being capable of extracting coloring matters from organic solutions. It may be used in decolorizing galenical preparations of drugs.

Purified animal charcoal is too powerful to use in decolorizing solutions of drugs, for it is capable of extracting organic principles, such as tannin, alkaloids and resins,* whereby the strength of the product would be lessened. Because of this behavior toward organic principles, purified animal charcoal has a distinct value as an antidote to alkaloids and other organic poisons.

All charcoals should be kept in well-closed containers, so that their absorbent power may not be exhausted by absorption of gases from the atmosphere.

Dental Uses.—About the only use to which charcoal could be properly put is to cleanse a foul mouth, such as is too often met with among ignorant people. Its practical application is questionable. It is not a proper ingredient of tooth powders, because of the sharpness of its particles.

Hydrogen Dioxide.—This compound, having the chemical formula of H_2O_2, is used in several strengths as an antiseptic. Its value depends upon the extra oxygen which it contains and which it gives up readily when brought into conditions that favor its decomposition. It is, therefore, an oxidizing agent, the oxygen liberated in nascent condition giving it three distinct properties which make it especially valuable in dental practice, it being a disinfectant, a detergent and a bleaching agent.

A compound that yields its oxygen so readily is, of course, unstable; but it has been found that a solution containing 3 per cent. of pure

* U. S. Dispensatory, eighteenth edition, page 329.

hydrogen dioxide in water keeps its strength and qualities for months at ordinary temperatures. Higher strength solutions require the addition of considerable acid or other preservative, and must be looked upon as unstable and dangerous to handle. A 25 per cent. ethereal solution is put up in closed glass tubes with certain precautions noted upon the label. In this strength the agent is a decided caustic and must be handled with care, its chief use being as a bleaching agent.

The official solution is called:

Liquor Hydrogenii Dioxidi.—Solution of Hydrogen Dioxide [H_2O_2]. This is a colorless liquid, slightly *acid* in reaction, and it contains when freshly prepared, not less than 3 per cent., by weight, of the pure dioxide. It is also known as the "ten volume" solution, as it yields upon decomposition about ten times its own volume of oxygen. The acid it contains is necessary to its preservation. Average dose, f℥1 (4 mils.).

The most characteristic property of this liquid is its foamy decomposition in contact with organic matter, by the activity of which its strength can be roughly estimated.

It gradually loses strength by keeping, though it is stated that deterioration will be retarded if the stopper of the bottle be coated with paraffin, or if a stopper of cotton be employed instead of an ordinary cork stopper. It should be kept in a cool place.

It decomposes when heated or exposed to sunlight, also when in contact with *charcoal, oxides of manganese, potassium permanganate, alkalies, blood, pus* and other loosely organized matter, besides many other chemical substances. Mixed with a solution of *potassium iodide* it liberates iodine. As a rule, it should be used alone, so as to avoid unexpected decomposition.

When the 3 per cent. solution is applied to the tissues it decomposes with some energy, because of the rapidity and abundance of the liberation of oxygen. Upon a tender mucous membrane the action may be so irritating as to require dilution of the liquid. The oxygen in nascent condition is a powerful germicide and disinfectant, cleansing the surface of the tissue thoroughly without injury, for it does *not coagulate,* nor constringe, nor penetrate. Its action is solely that of an oxidizing agent, and any irritation from it corresponds to the energy of oxygen liberation. As a gargle or mouth wash it may be employed in full strength of the official solution (3 per cent.) or diluted. With children it is usually diluted to one-half or one-quarter strength.

It should be regarded distinctively as an antiseptic that does not

injure healthy tissues. Its special value lies in its power to oxidize, disintegrate and destroy disorganized tissue, such as pus; and in disinfecting abscess cavities it has the further advantage of distending the cavity by the expansion resulting from the liberation of oxygen, so that every portion of the cavity and its walls are reached by the oxygen. Distention of an abscess cavity in this way will cause momentary pain, but scarcely more than attends the use of a coagulating or penetrating antiseptic.

In tooth and root-canal disinfection the dioxide is used freely. In removing pus and cleansing the pockets in pyorrhea, in the cleansing of ulcers and, in fact, in any local infectious condition, hydrogen dioxide is an ideal disinfectant. But the mistake should not be made of expecting of this substance properties that it does not possess. It is *not antacid,* it is *not coagulant,* it is *not astringent,* it does *not affect healthy tissue.* Its action is upon disorganized tissue, blood, pus and bacteria. The one indication for its use is the presence of infection. One exception must be made under the general statements as to its use in abscess cavities; it should not be used in the antrum with its unyielding bony wall, unless a very free opening has been made. Very severe pain might easily attend its use ordinarily in empyema of the antrum, on account of pressure from the rapid expansion of the liberated oxygen.

Systemic effects never occur from the proper use of hydrogen dioxide; therefore, it is *non-toxic.* However, by its hypodermic use some of the unchanged dioxide may be absorbed into the circulation and cause disorganization of blood elements with the production of emboli. An animal may easily be killed by intravenous injection of dioxide of hydrogen. As a bleaching agent this substance is discussed elsewhere.

Quininæ Sulphas.—QUININE SULPHATE $[(C_{20}H_{24}O_2N_2)_2.H_2SO_4 + 7H_2O]$. Quinine, the chief alkaloid of cinchona bark, is used in the form of various salts, but mostly as the sulphate. This occurs in white, silky crystals or as hard, prismatic needles; soluble in 725 parts of water, 107 parts of alcohol and in 30 parts of glycerin. [Acids aid the solubility of quinine and of the sulphate. The bisulphate and several other salts are much more soluble than the sulphate.] Average dose, tonic, gr. $1\frac{1}{2}$ (0.1 gm.) three times daily; anti-malarial, at least gr. 15 (1 gm.) daily.

While this drug is classed as antipyretic and anti-malarial, the latter action is most important and is really antiseptic. It is the most typical internal general antiseptic in use. Not only is its action in the digestive tract destructive of some of the intestinal infections, such as amebic

dysentery, but, in the blood of malarial subjects it readily destroys the plasmodium malariæ, which is the specific organism of malarial or intermittent fever. In order to be absorbed into the blood in sufficient strength to accomplish this it must be given in large doses daily for a week or more; but even thus it is comparatively harmless to the system, the only unpleasant effects being ringing in the ears and slight temporary deafness. The term *cinchonism* is applied to these symptoms of the full action of quinine. The former use of quinine in large doses, to combat inflammation (antiphlogistic), is now nearly obsolete.

Incompatibility.—(See Incompatibility of Alkaloids.)

Chinosol.—Quinosol [$C_9H_6N.KSO_4 + H_2O$] (not official).—Chemically this drug is oxy-quinoline-potassium-sulphate, occurring in yellow crystals having an astringent, aromatic taste and readily soluble in water, but insoluble in alcohol. It is *not a coagulant*, therefore not destructive to tissue. It may be used in a 1 : 1000 aqueous solution as a general antiseptic wash, but for local uses, such as application to abscess cavities, empyema of the antrum, etc., 1 to 2 per cent. solutions may be used.

Incompatibility.—With *lead acetate* or *mercuric chloride* precipitates will occur, while the addition of *ferric chloride* will produce a bluish-green color. Steel instruments are tarnished but not corroded by the drug.

Formaldehyde [CH_2O].—This valuable addition to our materia medica is a gas, usually obtained by the partial oxidation of methyl alcohol. It is one of the most powerful disinfectants known, ranking almost with corrosive sublimate. It fills a place that no other agent does as a really effective and practicable disinfectant gas. It is far superior to sulphurous acid gas in respect to efficiency, penetrating power and non-action upon metallic furnishings. Various lamps and other apparatus for generating the gas for extensive use have been devised, and small fumigators or candles for limited use, as in the disinfection of books, instruments and clothing in a small air space. The gas is very irritating to the eyes and to the air passages. As a medicinal agent formaldehyde is employed in its official aqueous solution, as below.

Liquor Formaldehydi.—Solution of Formaldehyde.—*Formalin.*—This is an aqueous solution containing not less than 37 per cent. of formaldehyde gas. It has a pungent odor and caustic taste, being irritant to tissues. It is the commercial form of the drug and is miscible with water and with alcohol in any proportion. It should be *neutral* or only faintly acid in reaction. Upon standing it may become cloudy

from the separation of paraformaldehyde. A stronger solution is unstable. A much weaker solution must be used for application to living tissues, for this substance is characterized by its *penetrating quality* and *irritant action*.

While this drug has the power to harden tissues to a marked degree, the action is not a coagulation in the ordinary sense. When applied to a mucous membrane, it does *not coagulate* appreciably. In contact with egg albumin it coagulates the latter only slightly. In fact, it seems to hinder the coagulation of albuminous liquids to which it has been added; for egg albumin and serum are not precipitated by heat, nor is casein coagulated by the rennet enzyme, after being thus treated.* Compared with carbolic acid, the local action of formalin is less corrosive and more penetrating; it is on the whole more irritating, except for the momentary pain caused by the former. The result of its action is a deeper hardening of the tissues to which it is applied. Because of the continued irritation which it occasions, it cannot be used extensively as a general antiseptic to the soft tissues, except in very dilute solution. Even for disinfection of the hands, it has been largely discarded as being too irritating for daily use. As a mouth-wash, 0.5 per cent. of formalin should never be exceeded. For disinfection of pulpless teeth 5 per cent. may be used, but many have discarded it as being undesirable in any efficient strength, and liable to work injury beyond the apical foramen.

On the whole, it must be said that formalin is not gaining favor as a general antiseptic for application to the tissues of the body. The experiments of Hunt and Jackson† rate the 1 : 200 solution of formalin as far inferior to the same strength of benzoic acid and to 1 : 2500 solution of mercuric chloride, for mouth disinfection. Harrington found that a 1 per cent. solution of formaldehyde failed to kill the *Staphylococcus pyogenes aureus* in sixty minutes, while a 2 per cent. solution required forty-five minutes, and a 5 per cent. solution twenty minutes to destroy the same organism.‡

As an agent to prevent the growth of mouth bacteria, Peck found pure formaldehyde in 1 : 1000 solution hardly one-fourth as potent as the same strength of bichloride of mercury solution.§ In his experiments formalin proved to be a dangerous escharotic when kept in contact with soft tissues.

* Cushny's Pharmacology, 5th edition, p. 479.

† Transactions of the Dental Society of the State of New York, 1904, p. 94.

‡ Annals of Surgery, October, 1904.

§ Dental Review, August, 1898, p. 607.

Formocresol, largely used in root canal work, consists of equal parts of solution of formaldehyde and cresol.

An important use of formaldehyde is in the hardening and preservation of anatomic and pathological specimens. A 5 per cent. solution of formalin is commonly employed. The advantages of this agent over alcohol is that the color of the specimen is better retained, and the tissue does not shrink to any great degree.

Paraformaldehydum.—PARAFORM.—Average dose gr. 8 (0.5 gm.). This polymeric form of formaldehyde occurs in white masses or powder, slowly soluble in cold water, more readily in hot water, insoluble in alcohol. It has a slight odor of formaldehyde, which, given off slightly at ordinary temperature, is evolved rapidly when heat is applied. This points to its extensive use, in the form of "formaldehyde candles," in disinfecting rooms and clothing.

In dentistry it is used in various combinations for root filling and pulp mummification. The following are favorite combinations:

For root filling:

Chloro-percha and Formaldehyde.

Guttapercha (baseplate)	10 parts
Chloroform	25 "
Eucalyptol	15 "
Thymol	2 "
Paraform	1 part

Dissolve the guttapercha in the chloroform. Dissolve the thymol in the eucalyptol, add the paraform, finely powdered, and shake well. Mix the two solutions, and keep the bottle open in a warm place until the chloroform has evaporated. (Prinz.)

For pulp mummifying:

Paraform	1 part
Thymol	1 "
Zinc oxide	2 parts

Glycerin sufficient to make a stiff paste. (Prinz.)

Hexamethylenamina.—UROTROPIN [$C_6H_{12}N_4$].—This substance is a chemical compound of formaldehyde and ammonia. It occurs in colorless crystals or white powder, soluble in 1.5 parts of water and in 12.5 parts of alcohol. Average dose, gr. 4 (0.25 gm.). The aqueous solution is alkaline. The chief value of urotropin is as an antiseptic to the urinary tract. The explanation of its action is, that when eliminated by the kidneys it is decomposed into formaldehyde and ammonia, the former acting then as an antiseptic. It is a very efficient agent, but the urine must be acid, in order to secure a reliable effect, and quite large doses, even up to gr. 20 (1.30 gm.), are often employed.

CHAPTER XII.

BLEACHING AGENTS.

THE art of removing discolorations of the teeth has for years engaged some of the best thought of the dental profession, with the result that today we may say that the bleaching of teeth has become a science. With causes of discoloration well known and properly classified, the chemical reactions necessary to discharge the color may usually be secured with certainty. Moreover, the appreciation on the part of the patient is usually commensurate with the effort expended.

The excellent chapter on "Discolored Teeth and their Treatment," by Dr. Kirk, in the *American Text-book of Operative Dentistry,* gives a systematic presentation of present-day knowledge of methods of bleaching discolored teeth, which must stand as the authority of today upon this special subject. The province of the chapter here presented is to deal with substances rather than detailed methods of their application. The chief agents employed to bleach teeth are discussed, therefore, as to their properties, action and, in general, their uses.

There must necessarily be a chemical basis for the action of these agents, for it is inconceivable that colors could be discharged by the action of such strong chemicals as chlorine and nascent oxygen without the occurrence of chemical reactions.

The substances employed in the treatment of ordinary discolorations are conveniently grouped into

(*a*) Agents that furnish free chlorine, or indirect oxidizers.

(*b*) Agents that furnish nascent oxygen, or oxidizing agents.

(*c*) Agents that have an affinity for oxygen, or reducing agents.

For the removal of metallic stains, additional agents, chiefly in the nature of solvents, are required. While the use of chlorine to secure a change of the metallic deposit to a chloride, followed by thorough washing with warm distilled water, is held to be the general rule of treatment, its final success may depend upon the solubility of the chloride. Chlorides are commonly soluble in water, but silver chloride is an exception, it being entirely insoluble. Hence, in removing silver stains the chlorine treatment is followed by a saturated solution of

sodium thiosulphate (hyposulphite), which is a solvent for chloride of silver. In removing stains of manganese the final washing must be with a solution containing oxalic acid. In case of mercurial stain, Kirk advises the use of an aqueous ammoniacal solution of hydrogen dioxide after the chlorine treatment.

CHLORINE GROUP.

Chlorine.—The value of chlorine gas as a bleacher depends largely upon its affinity for hydrogen, by which it may either directly break up the color molecule or liberate oxygen from the water molecule. In the former case it is a direct decolorizer, and in the latter it is indirectly an oxidizer. The gas is now seldom applied directly to the tooth, although the Wright method employed it this way with good results, but the complicated apparatus needed prevented its general adoption. At the present time it is applied either in solution or in a loosely combined preparation which yields it up readily.

The official preparations yielding chlorine in sufficient strength to be of any value in bleaching are the following:

Liquor Sodæ Chlorinatæ.—SOLUTION OF CHLORINATED SODA.—*Labarraque's Solution.*—This liquid contains at least 2.5 per cent. of available chlorine.

Calx Chlorinata.—CHLORINATED LIME.—This is a whitish powder containing at least 30 per cent. of available chlorine. The powder deteriorates upon exposure to the air, becoming moist and losing its strong odor of chlorine. If kept in metal containers it is unfit for bleaching teeth, because of the liability of metallic contamination. It is preferably kept in paraffined card-board packages or in bottles. To be fit for use it must be dry and should exhale a strong odor of chlorine.

When either chlorinated lime or Labarraque's solution of chlorinated soda is employed, it is, after being placed in the tooth, treated with any dilute acid, usually 50 per cent. of either acetic acid or tartaric acid, in order to free the chlorine more rapidly. The use of chlorinated lime in this way constituted the original Truman method of bleaching teeth.

The incompatibilities with chlorine are stated in the chapter on Antiseptics.

OXYGEN GROUP.

Hydrogen Dioxide.—This substance and its properties are discussed fully in the chapter on Antiseptics. While the official 3 per cent. solution possesses some degree of bleaching power, its use has been largely superseded by that of the "caustic pyrozone" or 25 per cent. ethereal solution. Its value depends upon the nascent oxygen which it liberates. Kirk* states that "more rapid and permanent effects are produced when the pyrozone solution is rendered alkaline," which may be done by the addition of a little of one of the solutions of the pure alkalies, either aqua ammoniæ fortior or solution of potassium or sodium hydroxide. Special care must be taken in handling and using the 25 per cent. solution, on account of its caustic action upon the fingers, which may be prevented by first oiling them.

Sodium Dioxide.—SODIUM PEROXIDE [Na_2O_2] (not official).—This occurs as a yellowish-white powder that absorbs water readily when exposed to the air, with deterioration of its activity. It is caustic, soluble in water, and strongly *alkaline*. Its value as a bleacher is threefold:

1. It liberates nascent oxygen as does hydrogen peroxide, but after parting with one of its atoms of oxygen it still possesses caustic and alkaline properties. (Kirk.)
2. It possesses some solvent power upon albuminous matter.
3. It has the power of saponifying fats.

Thus it not only acts as an oxidizer, but as a detergent.

It is applied in saturated aqueous solution, which must be prepared at a low temperature in order to avoid loss of strength. If weaker solutions are desired in some cases, they may be prepared from the saturated solution by diluting carefully with water.

Benzoyl-acetyl Peroxide.—ACETOZONE.—*Benzozone* [$C_6H_5COOOCOCH_3$] (not official).—In a comparative experimental study of bleachers† Dr. Hoff has obtained results that would seem to place this new agent next to hydrogen dioxide and sodium dioxide. He describes it as an organic peroxide, whose decomposition products are not destructive to the tooth structure. It acts slowly, and it may be allowed to remain for some time within the cavity.

This drug is obtained in form of a whitish powder, consisting of

* American Text-book of Operative Dentistry.
† Dental Cosmos, February, 1902.

equal parts of the pure crystal and an inert powder, which makes a cloudy solution in water. The solubility of the crystals in water varies from 1 : 1000 to 1 : 10,000. It is slightly soluble in alcohol and in ether. Nearly all solvents, including water and alcohol, decompose it gradually. It should be kept in small, well-stoppered bottles in a cool place, securely protected from moisture, and from contact with organic matter, alkalies, alcohol and other solvents.

In aqueous solution this drug is claimed to be a very powerful, non-toxic germicide.

Potassium Permanganate parts readily with its oxygen when brought into contact with organic matter. Its disadvantage as a bleaching agent is, that the resulting compounds are dark-colored and require to be treated with a solution of oxalic acid in order to complete the decolorization.

REDUCING AGENTS.

Sulphur Dioxide [SO_2] (not official).—A gas.

Acidum Sulphurosum.—SULPHUROUS ACID.—An aqueous solution containing not less than 6 per cent., by weight, of sulphur dioxide gas.

Both are bleaching agents by reason of their affinity for oxygen. However, they do not destroy organic pigments, as the color may be largely restored by an alkali or a stronger acid, according to Witthaus. The dioxide (SO_2) possesses the stronger affinity, being oxidized in the presence of water to sulphurous acid (SO_3H_2), and finally to sulphuric acid (SO_4H_2). The dioxide gas being preferable, Kirk advocates the use of a mixture of 10 parts of sodium sulphite and 7 parts of boric acid which, being packed into a tooth and moistened with water, may be quickly sealed in with a temporary filling. A reaction occurs between the two substances with liberation of sulphur dioxide. The bleaching process by this method is slower than by the use of the peroxides.

The solution in water known as sulphurous acid is less efficient than the gas, but still may be employed. It must be remembered that the final product of oxidation of this class of bleachers is sulphuric acid, which must be thoroughly removed or neutralized.

Incompatibility.—Sulphurous acid gas, or its solution, is incompatible with *acids,* with *ferric, mercuric,* and *silver salts,* with *carbonates* and with *solutions* of *iodine.*

Sodii Bisulphis.—BISULPHITE OF SODIUM [$NaHSO_3$].

Sodii Sulphis.—SULPHITE OF SODIUM [$Na_2SO_3 + 7H_2O$].

These salts are freely soluble in water, and when exposed to air lose

sulphur dioxide. They are of use as sources of sulphur dioxide gas when they are decomposed. In bleaching of teeth the sulphite chiefly is used, as in the process noted above. (See also under Antiseptics.)

Sodii Thiosulphas.—HYPOSULPHITE OF SODIUM [$Na_2S_2O_3 + 5H_2O$].—This salt, soluble in 0.5 part of water, is used in saturated solution to remove the silver chloride resulting from previous treatment of silver stains with chlorine.

CHAPTER XIII.

ANESTHETICS—LOCAL ANALGESICS.

Anesthetics are agents used to abolish sensibility, for the purposes of surgical treatment, the relief of spasm, and the alleviation of severe pain. Complete *general anesthesia* includes unconsciousness, due to paralysis of the cerebral cortex, and loss of excitability of all centers of reflex action, except those concerned in the functions of respiration and circulation. *Local anesthesia* means usually the abolition of sensibility to *pain* in a certain locality. It is rather a condition of *analgesia*, which is defined to be the absence of sensibility to pain, as distinguished from *anesthesia*, which means the absence of all sensibility.

When confronted by the necessity of a surgical operation, a decision must be made first as to the advisability of using an anesthetic, then, as to whether local or general anesthesia shall be employed, and finally the choice of the agent must depend upon the condition of the patient, the length of time required for the operation and the comparative safety of the drugs from which a selection is to be made.

In major operations the necessity of general anesthesia appears at once, and the chief point will be the choice of the drug to be used. In minor operations, such as the extraction of a tooth or the lancing of an abscess, we should not resort too readily to general anesthesia. We should rather allow the patient to assume the responsibility of deciding to take an anesthetic. And in case of a prolonged or severe operation in dental practice, the patient's physician should, as a rule, assume the responsibility of deciding what anesthetic shall be used, and also supervise its administration. The use of local analgesics may be more readily resorted to for any minor operation about the mouth.

LOCAL ANALGESICS.

These agents are employed to paralyze the sensory nerve endings to painful impressions in a limited region. They produce their effects in two ways, and are accordingly classified into:

Refrigerant Analgesics, or those which cause an abstraction of heat from the part, even to the point of freezing the tissue, and

Paralyzant Analgesics, or those which have a specific paralyzant action upon the sensory nerve terminals.

REFRIGERANT ANALGESICS.

Ice and salt mixture.
Rhigolene spray.
Ether spray.
Chloride of ethyl spray.

The value of all of these depends upon the operation of the physical law that *a solid in changing to a liquid, or a liquid changing to a vapor requires a certain amount of heat to effect the change.* The heat so required is abstracted from the surrounding medium and becomes latent in the new form of the substance, being necessary to the maintenance of that form.

When a mixture of *ice* and *salt* is applied to tissue, heat is abstracted so rapidly by the melting ice that the part may be frozen superficially. The only use of the salt in the mixture is, by its affinity for water, to make the ice melt more rapidly. It would be impossible to freeze tissue by the application of ice alone, because of the slow abstraction of heat. One danger in the application of ice and salt is freezing too intensely or too extensively, which may induce sloughing of tissue. The more salt there is added to the ice up to a certain point the more rapidly will freezing occur. Therefore, to a given quantity of ice, pounded fine, one-fourth to one-third as much salt should be added. They should be well mixed and applied in such manner that heat may be abstracted only from the part to be operated upon.

This mixture, probably the earliest of all local analgesics, must still be accorded a place of usefulness, although it has been largely superseded by the highly volatile liquids whose effects are so easily secured and controlled. It may be used upon an accessible surface, but within the mouth it is certainly inferior to a spray.

The liquids used for local analgesic purposes must be very volatile at or below the temperature of the body, so as to evaporate rapidly when sprayed upon the tissues. The following have been employed:

Æther (Ethylic).—Boils at about 95° F. It is very inflammable, the vapor forming an explosive mixture with the air.

Rhigolene (not official), a distillate of petroleum, boiling at 65° F. It may be explosive under certain conditions.

Æthylis Chloridum.—Ethyl Chloride.—Boils at 55° F. As a liquid it burns with a smoky flame; and its vapor is very inflammable.

The comparison of boiling-points and inflammability of the above agents indicates the superiority of ethyl chloride, which is practically the only one used at present.

Chemically, *ethyl chloride* [C_2H_5Cl] is an ester resulting from the action of hydrochloric acid gas upon absolute alcohol. It is a colorless liquid, inflammable and extremely volatile, with a specific gravity of 0.918 at 46.4° F. The specific gravity of its vapor is 2.22. It is put up for use in sealed tubes containing ½ or 1 fluidounce. By means of a capillary opening through the glass stopper a very minute jet is emitted, which is directed upon the part to be frozen. Thus there is no waste, and the fine stream may be forced a distance of a foot or more, especially if the pressure within the tube be increased by enclosing it in the warm hand. The action of the drug is, therefore, easily controlled and may be secured at any point within the mouth without endangering the tissues.

Fig. 4.—Chloride of ethyl spray tube.

Some pain attends the freezing of tissue by whatever means induced, but this disadvantage is outweighed by the assurance the patient acquires that the pain of the operation will be much lessened.

Indeed, for the extraction of a tooth, the mental effect of the harmless chloride of ethyl application may be taken advantage of to nerve a hesitating or nervous person up to a point of ready coöperation. With this agent several teeth may be extracted at one sitting with practically no danger; however, by inhalation the drug has been found to be a quick and powerful general anesthetic, whose safety seems to be less than that of ether; so that, in its local use in the mouth, care should be exercised to avoid the occurrence of general anesthesia. One-half to one fluidrachm (2–4 mils) quickly inhaled may easily cause unconsciousness. The full effect of the local application is shown by blanching of the tissues at the point of evaporation. The action being chiefly upon the gums, the real advantage to be sought is painless application of the forceps. We cannot expect the actual pain of extraction to be entirely removed.

On the whole, the use of this substance is to be highly recommended.

Its convenience, readiness, safety and comparative efficacy give it a sum of advantages not possessed by any other local analgesic for slight operations. As a general anesthetic it is considered in Chapter XIV.

PARALYZANT ANALGESICS.

The *paralyzant* class of local analgesics includes the following drugs, which are here compared as to solubility, their other properties and uses being discussed in regular order. The first three are official.

Cocaine Hydrochloride, soluble in 0.4 part of water, 2.3 parts of alcohol.

Beta-eucaine Hydrochloride* soluble in 30 parts of water and in 35 parts of alcohol.

Quinine and Urea Hydrochloride, soluble in 1 part of water and in $2\frac{1}{2}$ parts of alcohol.

Tropacocaine Hydrochloride, readily soluble in water.

Nirvanin, easily soluble in water.

Stovaine, soluble in 2 parts of water and readily in alcohol.

Alypin, very soluble in water and in alcohol.

Novocaine, soluble in 1 part of water, freely in alcohol.

Apothesine, readily soluble in water and in alcohol.

Orthoform, slightly soluble in water, freely in alcohol.

These all obtund or paralyze the sensory nerve terminals wherever they are applied, affecting chiefly sensibility to pain. They produce very little effect upon the unbroken skin. Upon mucous membrane, whose texture is less firm, their effect is decided, but their full action is only obtained when they are applied to a denuded surface or injected hypodermically; except, that in the application to the very sensitive mucous membranes of the eye a complete effect is quickly obtained, although no abrasion be present.

Three dangers are recognized as pertaining to the use of these drugs:

1. Damage to the tissues treated, leading at times to sloughing.
2. General poisoning.
3. Formation of habit.

TECHNIQUE OF LOCAL ANESTHESIA.

To attain success in the practice of local anesthesia it is essential that the operator should possess suitable instruments and exercise infinite care in the preparation and use of the solution selected.

The syringe should be strongly constructed and should permit of

* Alpha-eucaine, being more irritating, is now seldom used.

sterilization by boiling. Such syringes may be of the all-metal type or the barrel may be of glass. The needles should be selected with due regard to the accessibility of the part to be operated upon.

The solution should be freshly prepared for each case. It is convenient to use tablets containing definite amounts both of the drug and of synthetic suprarenin. These should be dissolved in either normal

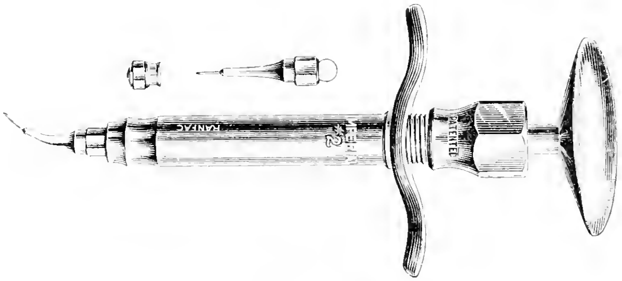


Fig. 5.—Hypodermic syringe.

saline* or Ringer's solution.† A 1 or 2 per cent. solution of the drug is suitable for all dental operations. There are on the market small graduated porcelain dishes with standard and handle, in which the solution may be prepared and, where permissible, boiled over a Bunsen burner or alcohol lamp.

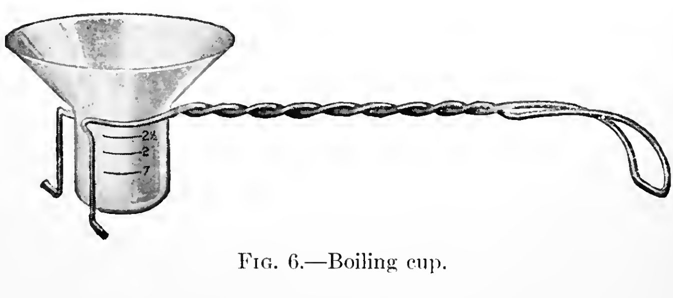


Fig. 6.—Boiling cup.

The injections about the teeth may be made in any of the following ways according to the requirements of the case: Subperiosteal, intraosseous, peridental or submucous. The area to be injected should first be painted with tincture of iodine diluted with an equal quantity of grain alcohol. Thorough asepsis should be practised throughout the operation.

* Normal saline solution is known officially as *Physiological Solution of Sodium Chloride* and consists of 0.85 per cent. of sodium chloride in distilled water.

† Ringer's solution imitates closely the salinity of the blood plasma, containing, in distilled water, sodium chloride, 0.7 per cent.; potassium chloride, 0.03 per cent.; calcium chloride, 0.025 per cent.

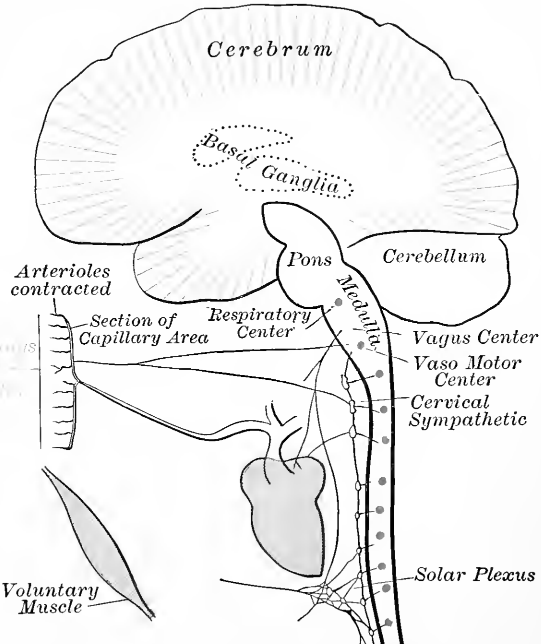
COCA.

The leaves of Erythroxylon Coca and its varieties.

The alkaloid Cocaine fully represents the drug.

Classified as :

Cerebral stimulant.
Mydriatic.
Local analgesic.
General protoplasmic poison.



Physiologic action:

The drug produces first a descending stimulation of the central nervous system, followed by a descending depression if a large dose has been taken. The succession may be irregular, so that a case of cocaine poisoning may show mixed symptoms of stimulation and depression.

The two diagrams presented (Plates II. and III.) show the stimulant and depressant effects respectively.

Stomach. The local effect is to benumb the sensory nerve endings in the stomach.

Nervous System.

Brain. Stimulates the cerebral cortex.

Medulla. Stimulates respiratory and vasomotor centres.

Spinal cord. Stimulates reflex centres.

Sensory nerve endings are always depressed when the drug is applied locally.

Muscular System. Increases irritability and working power of voluntary muscles.

Eye. Dilates pupil by stimulating dilator nerves.

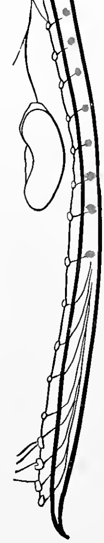
Circulation. Arterial pressure is increased.

Heart. Action accelerated by direct stimulation either of heart muscle or of the accelerator nerves.

Capillary area. Contracts arterioles by stimulation of vasomotor centre in the medulla and by direct action upon the vessel walls.

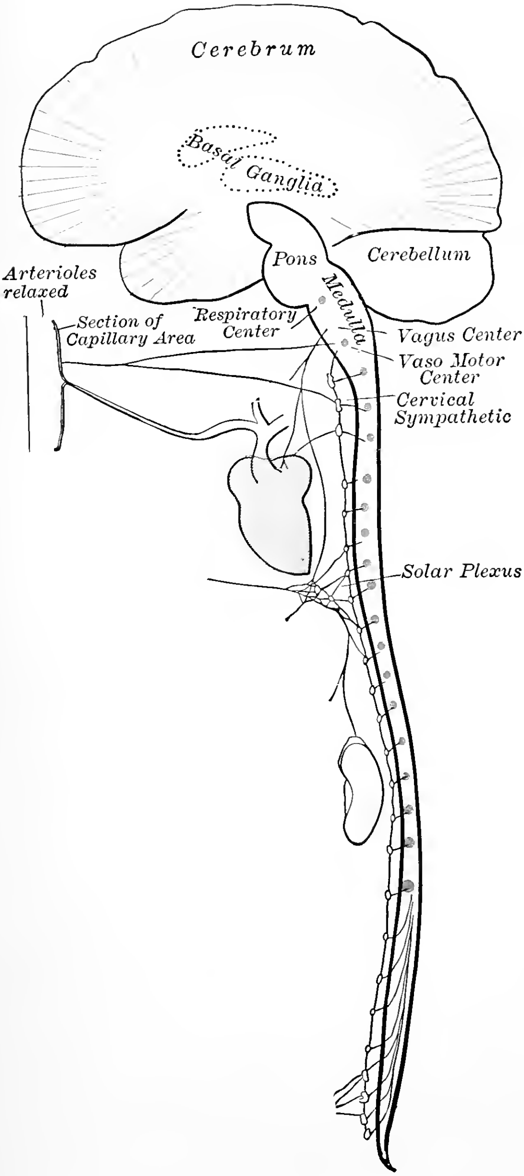
Respiration. Rate increased by stimulation of respiratory centre.

Elimination. Cocaine has been detected in the urine, but its influence upon the kidneys is variable and uncertain, therefore probably indirect.



The red color indicates the stimulant effects of Cocaine.

PLATE III.



The blue color indicates the depressant effects of a toxic dose of Cocaine.

COCAINE.

The poisonous effects of Coca, or the secondary effects of a large dose, are depressant, following quite definitely the lines of previous stimulation.

Nervous System.

Brain. Cerebral functions are depressed, frequently with production of narcosis or convulsions.

Medulla. Depresses respiratory center and probably vaso-motor center.

Spinal cord. Depresses reflex centers.

Circulation. Arterial pressure is lessened.

Heart. Depressed by direct action of the drug.

Capillary area. Arterioles relaxed, probably through paralysis of vasomotor center.

Respiration. Depresses the respiratory functions by lessening the irritability of the center in the medulla.

In general, the depressant action is that of a general protoplasmic poison, the commonest evidence of which is its paralyzant influence upon nerve tissue when locally applied.

For local analgesic purposes the alkaloid Cocaine is employed in from ½ to 4 per cent. solutions.

CONDUCTIVE OR REGIONAL ANESTHESIA.

In addition to the simple local use of this group of drugs, their application has been extended to anesthetize a whole extremity or region supplied by a certain nerve. This is accomplished by injection of the drug into and about the nerve at some point in its course. If thoroughly done, painful sensation will be abolished in all the region of distribution of the nerve. While this method may be employed to secure anesthesia for a surgical operation, the same is also advocated to prevent shock from operations upon the extremities.*

This method of producing regional anesthesia is coming into wide use by the dental practitioner and possesses many points of merit. But before this method is taken up the dentist should become thoroughly familiar with the technique as well as possess an exact knowledge of the anatomy of the parts. It is also quite necessary that the operator possess the necessary paraphernalia for properly carrying out the exacting technique of this method. Injections should be made at the point where the trunk of the nerve supplying the part may be reached, as in the following locations: zygomatic, infra-orbital, anterior palatine, posterior palatine, pterygomandibular or mental, according to the areas which are to be anesthetized. The student is referred to the more exhaustive treatises on this subject for the minute details of technique.

Cocainæ Hydrochloridum [$C_{17}H_{21}O_4NHCl$], average dose gr. $\frac{1}{4}$ (0.015 gm.).—This agent stands as the typical local analgesic. It is a neutral salt of the alkaloid cocaine, from the leaves of *Erythroxylon coca*, grown chiefly in Peru and Bolivia. While the alkaloid was discovered about 1860, and its peculiar analgesic power observed soon after, its introduction to the medical world as a practical local analgesic was due to Karl Koller, who in 1884 reported experiments to the Congress of German Oculists. In a few weeks cocaine was being used all over the world.†

Administered internally, the coca leaves and their preparations, as well as the alkaloid, are stimulating to the nervous system in small doses and depressing and poisonous in large doses. (See Plates II and III.)

Locally applied to sensory nerves, cocaine is always depressing. Applied to the tongue it removes the sense of taste for bitter substances, diminishes it for sweet and acid substances, while for salt it is not appreciably lessened. When taken into the stomach it diminishes the

* See footnote on page 170.

† Park's History of Medicine.

sensibility of the organ, thereby lessening the sense of hunger, and probably impairs the activity of digestion. The sense of touch may be lessened by it, but the most marked result of its application, and the most desirable, is the removal of the sense of pain. The temperature sense for heat and cold is not diminished. Applied locally into the eye it causes dilatation of the pupil in addition to the analgesic effect. It usually is applied as directly as possible to the terminal endings of the sensory nerve, but will produce the same effect if applied to the nerve trunk anywhere in its course.* It should be noted that cocaine has a deleterious effect upon all kinds of tissue when applied in any but very small quantities; therefore it is classed as a general protoplasmic poison. The reason for the prominence of its effect upon nerve tissue is, that we are here dealing with the tissue that is a medium of sensation and expression, and its impairment is, therefore, more easily appreciated. Being one of the drugs that combines a stimulant (early) effect with a depressant (later) effect, the greatest degree of caution must be exercised to avoid the habitual use of the drug by patients. It is one of the most seductive of the drugs that are taken habitually, and its effects are most disastrous. Particularly is it unwise to order this drug for the patient to use at home, whether as gargle, mouth wash or nasal spray.

Observation has shown that the system acquires a tolerance of large doses of cocaine when it is taken habitually, as is the case with morphine, the quantity taken daily in some cases reaching as high as 30 grains. The drug is often taken as a substitute for morphine, or as an antagonist to it. The effects of cocaine taken habitually seem to be more rapidly disastrous than those of morphine.

In the practical use of the drug the *hydrochloride of cocaine* is preferred to the simple alkaloid, because of its greater solubility. Alkaloids, as a rule, are only sparingly soluble in water, hence their salts are commonly employed. Cocaine illustrates this rule, being soluble only in 600 parts of water, while the hydrochloride is soluble in 0.4 part of water. It is also soluble in 2.3 parts of alcohol.

* We are indebted to Dr. G. W. Crile for some facts concerning the value of cocaine in blocking nerve trunks to the transmission of sensory impressions from an injured part of the body. By very careful experiments he has come to the conclusion that one prominent factor in surgical shock is the depression of the vasomotor system by exhaustion of the centers. This occurs through their excessive stimulation by sensory impressions coming from the site of injury or operation. In operations upon the extremities, he prevents shock by "nerve-blocking" with cocaine, *i. e.*, by injecting the drug about the nerve trunk so as to abolish its power of carrying sensory impressions.

It is obtained in form of crystals or a crystalline powder, permanent in the air and bitter to the taste, leaving a sensation of numbness on the tongue.

Solutions of cocaine hydrochloride do not keep well beyond a few days, neither can they be sterilized by boiling without impairing their value. The practitioner must either make up his solution when needed, renew it frequently, or else add some antiseptic to preserve it. If it is desired to keep the solution more than a few days a very little phenol ($\frac{1}{2}$ to 1 per cent.) may be added to prevent the growth of organisms, and in this strength the coagulant action of the latter drug is scarcely noticed. Boric acid likewise is used as a preservative in the proportion of $2\frac{1}{2}$ per cent. in the aqueous solution of cocaine. Salicylic acid is also recommended in the strength of 0.1 per cent. (1 : 1000). Chloretone is used by some in the strength of $\frac{1}{4}$ to $\frac{1}{2}$ per cent.

Local Action of Cocaine.—The chief interest of the dental surgeon in this drug centers about its use as applied locally to, or injected beneath, the mucous membrane. When applied to the membrane of the mouth the bitterness of the drug is marked. The pure crystal or a strong solution, 5 to 10 per cent., will cause some anemia of the surface, which is probably due to a constrictor action upon the arterioles, and at the same time sensitiveness of the tissues to pain will be abolished to the depth of penetration by the drug. For surface treatment, or upon so sensitive a mucous membrane as that of the eye, direct application of cocaine in 1 to 4 per cent. solution is sufficient; but for extraction of teeth such application is of no use. The drug must be injected into the tissues about the socket of the tooth. When this is done there occurs immediately a blanching of the tissues at the site of injection, which is due partly to forcible distention by the fluid injected, and probably partly to vascular constriction. Some pain attends the use of the drug in this way, but it occurs only at the moment of injection, and is quickly succeeded by complete analgesia of the locality. The vasoconstriction is often followed by a relaxation that permits hyperemia of the tissues, which may be more or less painful. This, however, must be regarded as a secondary and later effect, occurring rather after than during the operation.

Dosage.—The strength of cocaine solutions employed varies from $\frac{1}{2}$ to 4 per cent., according to the rapidity and degree of effect desired, the total quantity used being limited by considerations of safety. The maximum quantity allowed to gain entrance into the circulation at one time should not exceed one-quarter of a grain. This ought to be the

limit in the ordinary use of the drug by hypodermic injection. However, the free bleeding of the tissues following extraction will remove some of the drug, and may modify our estimate of the quantity that may be safely injected in a given case. A 1 per cent. solution will usually suffice, and of this twenty-five minims contain one-quarter of a grain. When application is made to the surface of the mucous membrane of the mouth, or when the drug is used by cataphoresis, stronger solutions may be required; and when the drug is so applied that absorption occurs only through the unbroken mucous membrane, a larger quantity may be used, but should never exceed one-half of a grain, which is the maximum dose for stomach administration. For direct application to the pulp of a tooth, a small quantity of a stronger solution or a little of the pure crystal may be employed.

An excellent rule in the interest of exactness of dose and ease of calculation is given by Burchard.* It is "to make the solution upon the basis of 8 grains of the cocaine salt to 1 ounce of the menstruum which will give 1 grain in each drachm and $\frac{1}{60}$ of a grain in each minim." This solution would be a little less than 2 per cent. in strength. Ten minims would equal $\frac{1}{6}$ of a grain, which would be within the safe hypodermic dose for an adult.

That this drug is one of the most dangerous of those in daily use is attested by the many cases of cocaine poisoning that are upon record. Among those well authenticated is the case of a girl, eleven years of age, whose death resulted in forty seconds from the hypodermic injection of 12 drops of a 4 per cent. solution, or about $\frac{1}{2}$ grain.† In another case death is said to have been caused by the application of 20 drops of a 5 per cent. solution (1 grain) to the gum.‡

Among other cases of severe poisoning by cocaine, without a fatal result, the following are noted:§

T. H. Burchard reports a case in which 10 drops of a 4 per cent. solution hypodermically caused unconsciousness and apparent death in four minutes; Meyerhausen, a case in which 8 drops of a 2 per cent. solution upon the conjunctiva of a girl of twelve years produced violent symptoms; Stevens, one in which 4 minims of a $3\frac{1}{2}$ per cent. solution caused, in a man, violent convulsions followed by mania; Frost, a case of a child of fourteen in which 1 drop of a 1 per cent. solution in the eye caused marked poisoning. Idiosyncrasy must probably account for

* American Text-book of Operative Dentistry, second edition, page 641.

† Wood's Therapeutics, eleventh edition, page 201.

‡ Ibid.

§ Ibid.

the occurrence of such cases, but the fact that they are not rare should lead to great care and discrimination in the employment of cocaine.

Schleich Infiltration Method. This consists of infiltration of the tissues with a very weak solution of cocaine by a series of contiguous injections, which produce really a local edema. Three different strengths of cocaine, approximately 1 : 500; 1 : 1000 and 1 : 10,000, are employed as the case demands.* To the solution is added 0.2 per cent. of sodium chloride and small quantities of morphine hydrochloride and phenol. The 1 : 1000 is the strength commonly used. Undoubtedly the pressure of distention by the larger bulk of solution injected contributes to the analgesia, for it has been found that forcible distention of tissues by sterile water often suffices for slight operations. This method has the advantage of permitting a large quantity of solution to be used, and a longer operation to be performed with much less danger of cocaine poisoning.

A number of ready-made solutions for local analgesia are upon the market. They are primarily commercial articles, and it is safe to say that cocaine or some substitute forms the basis of their formulas. There is no reason why a qualified practitioner should select a commercial formula instead of making up his own solution, when using so powerful a drug.

There is absolutely no guarantee of the composition and uniformity of the proprietary analgesic preparations, even though the names of ingredients are given; while if the practitioner orders by his own formula of official drugs, his pharmacist can guarantee accuracy.

The advantages claimed for special formulas are: *first,* that they contain substances that aid the desired action and permit a lessening of the quantity of cocaine used; *second,* that they contain one or more physiologic antagonists to cocaine, which will counteract any possible toxic action; or, *third,* that they keep better than a simple solution of cocaine. All of these objects are desirable, but it is better for the dentist himself to intelligently and scientifically select his own aids and antag-

* The precise formulæ of the three solutions are as follows:

	I. parts.	II. parts.	III. parts.
Cocaine hydrochloride,	0.2	0.1	0.01
Morphine hydrochloride,	0.025	0.025	0.005
Sodium chloride,	0.2	0.2	0.2
Phenol (5 per cent.),	0.30	0.30	0.30
Distilled water (sterilized),	100.00	100.00	100.00

onists to the drug. This implies a knowledge, on his part, of the physiologic action of the various drugs proposed, and the ability to note the indications for the selection of one or another in a given case. And this is not too much to expect of the trained practitioner of today.

As a type of combination that will be found generally applicable, the following is suggested:

		Gm. or mil.	
℞.—Cocaine hydrochloridi		16	(gr. iiss)
Atropinæ sulphatis		008	(gr. $\frac{1}{8}$)
Strychninæ sulphatis		03	(gr. ss)
Phenolis		12	(♏ij)
Aquæ destillatæ	q. s. ad	15	(f℥ss)—M.

The cocaine strength of this solution will be 1 per cent., and each 15 minims will contain $\frac{1}{6}$ grain, with $\frac{1}{120}$ grain of atropine, and $\frac{1}{30}$ grain of strychnine. One or two drops of adrenalin solution (1 : 1000) may be added, if desired, to each quantity of injection. The carbolic acid present is for preservation. Even less will suffice to keep the solution for some time.

Prinz* suggests that the solution should be made isotonic with the blood, so as to preserve normal cell osmosis, which is doubtless an advantage in the matter of lessening the irritation caused by the solution. He states that to make a 1 per cent. solution of cocaine isotonic requires the addition of 0.8 per cent. of sodium chloride, making the following proportions:

Cocaine hydrochloride,	5 grains
Sodium chloride,	4 "
Sterile water,	1 fluidounce.

To each syringeful (30 minims) he adds 2 drops of adrenalin choride solution when used.

General Action of Cocaine.—Plates II and III are intended to illustrate the action of the drug upon the different parts of the system.

General Uses.—Cocaine has come to be relied upon for the relief of pain and irritation wherever it can be locally applied. Its local analgesic action renders it of great value in minor surgery, and, properly adapted, it is useful for operations of considerable extent. A typical occasion for its use would be the removal of a foreign body from the eye. Here the instillation of a few drops of a 2 per cent. solution will quickly abolish painful sensation and lessen reflex sensibility to such a degree as to permit of easy removal of a foreign body even from the cornea.

* Dental Cosmos, September, 1908, p. 931.

Itching in various parts of body may require its application, either in aqueous solution or in form of the oleate. Painful conditions in the lower part of the bowel, as in dysentery, call for its use in form of suppository. In coryza it is useful in form of solution sprayed or dropped into the nostrils, but such use prolonged, or that of a cocaine snuff, presents great danger of habit formation.

Internally it may be of use in persistent vomiting when this is dependent upon irritation in the stomach. Its use as a substitute for morphine in habitual use of the latter should be advised against, as it proves no aid in overcoming the habit, while the result is likely to be the continuance of both drugs or substitution of cocaine habit for morphine habit, which is no improvement.

Earache, when not relieved by warm irrigation, calls for the application of cocaine; three drops of a 3 or 4 per cent. solution dropped into the ear will usually suffice. [A $\frac{1}{4}$ grain tablet (0.015 gm.) dissolved in eight drops of water, one-half used and repeated if needed.]

Incompatibility.—Cocaine hydrochloride is incompatible with *alkalies* and *alkaline carbonates,* with *tannic acid,* with *potassium iodide,* and with some *metallic salts.* It is decomposed by *potassium permanganate.* With solution of *silver nitrate* a white precipitate of chloride of silver occurs. A white precipitate occurs with a solution of *borax* or with a strong solution of *phenol.*

Aids to the Action of Cocaine.—Other agents of the same class, that are less poisonous and sufficiently soluble, may supplant cocaine or be combined with it. It is preferable, in the interest of accuracy, to use the drugs separately; so that mixtures of cocaine with its substitutes need not be considered. For prolonged effect, as in nerve blocking, *quinine* and *urea hydrochloride* is a useful addition, but it is injected separately. If there is an open wound or denuded surface, as in case of a burn, *orthoform powder* is useful. Agents that lessen the blood supply to the part, as cold applications, will aid slightly.

The use of *adrenalin* or other *suprarenal products* as an aid to the action of cocaine has become established. The claim that less cocaine is needed when so combined is borne out in the experience of surgeons. Two factors in its action serve to explain its value: first, it contracts the arterioles locally, thus lessening the amount of blood in the injected area; and, second, it lessens the activity of absorption into the circulation beyond the locality.

It is evident that, with the local circulation lessened by vasoconstriction, less cocaine is likely to pass into the circulation in a given time,

which means that more remains just where its effect is wanted, and the danger of systemic poisoning is lessened. The combination is easily made by adding, to the solution of cocaine hydrochloride for each injection, several drops of the 1 : 1000 adrenalin chloride solution. Reports indicate that the cocaine strength of the solution can be considerably reduced. One series of 100 operations,* which included resection of the superior maxilla, removal of a goitre and complete removal of the larynx, were performed under the use of a solution consisting of 9 parts of a $\frac{1}{2}$ per cent. solution of cocaine and 1 part of adrenalin (1 : 1000).

If the part to be operated upon admits of a ligature being placed about it, the entrance of cocaine into the general circulation may thus be limited and its local effect prolonged. Morphine has no local analgesic action,† therefore it is without value as an aid to cocaine.

Poisonous Effects.—*Antagonists.*—Poisoning by cocaine may be due to a weakened condition of certain organs whereby they are rendered more susceptible of depression, or to an overdose (see Plate III), or to idiosyncrasy. The symptoms are variable, hence cocaine poisoning presents no distinct picture. While the drug has the power to first stimulate and later depress the central nervous system, depression in some part may occur suddenly with irregularity of symptoms. The toxic effects may include:

(*a*) Depression of the brain, manifested by narcosis or spasm.

(*b*) Depression of the medulla and spinal cord, as shown by failure of respiration and depression of vasomotor and reflex activity.

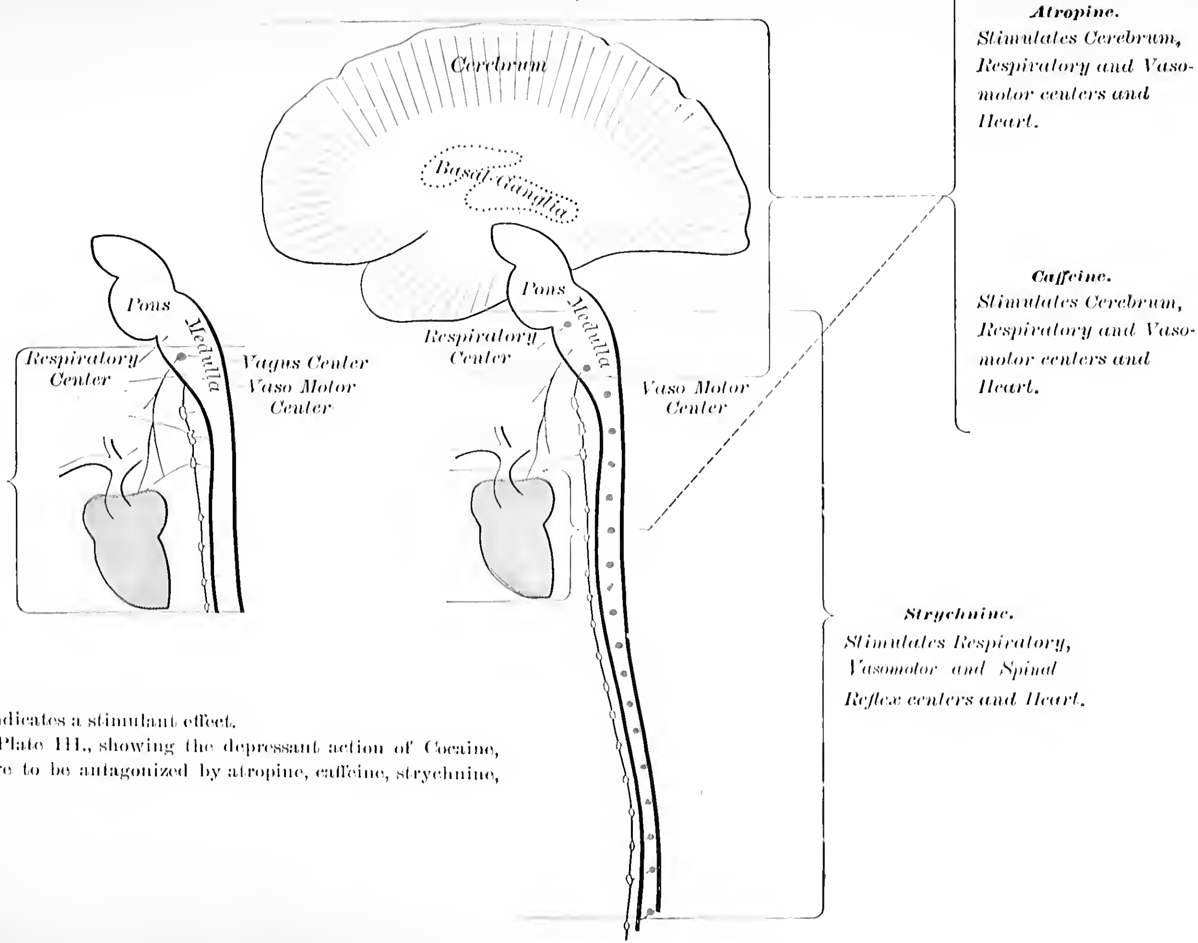
(*c*) Direct depression of the heart, which, with lessened vasomotor control, causes a marked fall of arterial pressure.

The most serious conditions, then, are depression of heart, vasomotors and respiratory center. The combined result of these is to lessen the arterial pressure very decidedly, with a certain degree of asphyxia added. These are the conditions to be antagonized. Therefore, it appears at once that any agent that does not either stimulate the vasomotor system, the heart, or the respiratory center, is of no value. Nitrite of amyl and nitroglycerin dilate the arterioles by depressing the vasomotor system; they do not stimulate respiration and their direct action upon the heart is doubtful. Therefore, they should never be used to antagonize cocaine, chiefly because they will still further

* See Gould's Year Book of Medicine and Surgery, 1905 (Medical vol.), p. 472.

† See note on page 87.

PLATE IV.



The red color indicates a stimulant effect.

Compare with Plate III., showing the depressant action of Cocaine, which is shown here to be antagonized by atropine, caffeine, strychnine, and digitalis.

reduce the arterial pressure.* Our best antagonists will be those that increase arterial pressure by stimulation of both vasomotor centers and heart, and which at the same time stimulate the respiratory center. Three agents that act in all three ways are caffeine, strychnine and atropine (see Plate IV). Caffeine has a dose of 1 to 5 grains (0.06–0.30 gm.) and is soluble in not less than 25 parts of water;† therefore it would be an impracticable substance to include in a cocaine solution. The proper salt of caffeine for hypodermic use is the official caffeine sodio-benzoate, soluble in 1.1 parts of water, dose 3 to 5 grains (0.20–0.30 gm.). The dose of strychnine sulphate is $\frac{1}{60}$ to $\frac{1}{10}$ of a grain (0.001–0.006 gm.) and of atropine sulphate $\frac{1}{120}$ to $\frac{1}{60}$ of a grain (0.005–0.001 gm.), and both are sufficiently soluble so that they may be combined in the same solution with cocaine. The dose for injection at one sitting should not exceed $\frac{1}{4}$ grain of cocaine hydrochloride, $\frac{1}{120}$ of atropine sulphate, and $\frac{1}{30}$ of strychnine sulphate; then in case of danger symptoms from the cocaine the other drugs may be repeated in the same dose, but the atropine sulphate not more than once. It is well to have at hand separate hypodermic tablets of these drugs in the doses mentioned, not for routine administration in every case, but for use according to the operator's judgment. It would be unwise to depend upon these in order to exceed the safe dose of cocaine, but in persons known to be susceptible to its depressant action, or where such susceptibility is feared, it is proper to employ these antagonists in advance of the injection of cocaine.

When poisoning occurs unexpectedly we may use the remedies mentioned above for the purpose of stimulating the whole central nervous system, in order to induce activity of cerebral functions, of respiration, and of circulation. Plate IV illustrates the action of these and of digitalis, which also is indicated if the circulatory failure is at all persistent. In this emergency f℥ $\frac{1}{4}$–1 (1–4 mils) of tincture of digitalis may be given hypodermically. But it must be remembered that digi-

* Nitroglycerin has been mentioned as an antagonist to cocaine, but it is contra-indicated when blood-pressure is low. If there is much depression of the circulation it may do harm by further reducing blood-pressure. It is doubtful whether nitroglycerin has any direct stimulant action upon the heart. (See Plate XIII.)

† *Caffeine* in its simple form is soluble in 46 parts of water and 66 parts of alcohol at 25° C. (77° F.), but the addition of benzoate or salicylate of sodium renders it very soluble in water. Thus *Caffeine-sodium salicylate* is soluble in 2 parts of water and *caffeine-sodium benzoate* in 1.1 parts. Either may be used hypodermically in dose of 3 to 5 grains (0.20–0.30 Gm.).

Citrated caffeine forms a clear, syrupy liquid with about 4 parts of hot water. Upon dilution with water, this yields a white precipitate (caffeine), which redissolves when about 25 parts of water have been added.

12

talis is a slowly acting drug and cannot be relied upon alone for sudden emergencies.

Adrenalin is among the most useful of agents for stimulating a depressed circulation. It acts both by direct stimulation of the heart and by constriction of arterioles, causing a decided rise of arterial blood-pressure. The disadvantage of uncertainty of action, unless employed intravenously, lessens its practical value in emergency cases. It gives no result when administered by the stomach and very little when injected hypodermically in ordinary quantities; but its use by the latter method may be resorted to in emergency, 1 to 5 mils of the 1 : 1000 solution, diluted with ten times as much normal saline solution, being employed. Another of our most efficient circulatory stimulants is camphor, dissolved in oil, given hypodermically. The dose is gr. 1 to 5 (0.06-0.30 gm.).

Immediate stimulation of both respiration and circulation should be secured also by administering, and applying to the air passages, some of the irritant agents that stimulate reflex activity by irritating sensory nerve endings. The chief preparations that act in this way are water of ammonia and spirit of camphor by inhalation; and for administration by the stomach, aromatic spirit of ammonia or alcohol, each in dose of 15 to 60 minims diluted with as much water. If necessary, repeat the dose of any in ten or fifteen minutes.

The fact holds that these agents are useful mainly by reason of their irritant action. They should, therefore, be given without much dilution, so that their effect upon sensory nerve-endings in the mouth, throat, esophagus and stomach may be decided, and the consequent reflex stimulation of heart and respiratory center be efficient. Irritation of the skin by friction, slapping or faradism will act in the same way.

If there be considerable depression of the respiration, as shown by slow or weak movements of the chest or by cyanosis, artificial respiration should be resorted to in order to secure proper oxygenation of the blood. (See Artificial Respiration.) In connection therewith massage of the heart by an assistant, by pressure between diaphragm and chest wall particularly with the movement of expiration, has come to be employed as an important aid in reëstablishing the heart's efficiency. It is most effectual in cases where the irritability of the heart muscle is not much impaired.

Substitutes for Cocaine.—The following list comprises the chief drugs that have been substituted for cocaine from time to time, some of which have been found wanting in essential qualities, some are still under

trial, while others answer the purpose in varying degree. It is evident that any agent, in order to be entitled to consideration, must compare favorably with cocaine not only as to efficiency, but in addition must be less toxic, or its solutions must keep better, or it must possess some other decided advantage.

Alypin.
Apothesin.
Beta-eucaine.
Nirvanin.
Novocaine.
Stovaine.
Tropacocaine.

The two following are used for a slower and more prolonged effect:

Orthoform.
Quinine and Urea Hydrochloride.

These drugs are mostly alkaloidal in nature and, therefore, used largely in form of a soluble salt. Their properties will be noted briefly and comparisons of their efficiency and adaptability given in tabular form.

Alypin (not official).—This name is usually applied to alypin hydrochloride, though the nitrate also is upon the market. As experiments have shown alypin to be fully as poisonous as cocaine (see pp. 182–183), it is destined to be discarded as a substitute. Its only place would seem to be in form of the nitrate when it is desirable to use a local analgesic in combination with silver nitrate, with which any soluble chloride would be incompatible. Alypin is freely soluble in water and in alcohol.

Apothesin (not official).—This is one of the newer synthetics for which important advantages are claimed, but the experiments of Sollmann seem to place it low in the scale of efficiency. (See pp. 182–183.) However, many practitioners have found it valuable.

Beta-eucaine Hydrochloride is a white, crystalline, odorless powder, soluble in 30 parts of water and in 35 parts of alcohol. It is about one-half as efficient as cocaine and about two-fifths as toxic. Its solutions keep well. It is more irritating than cocaine and it combines less efficiently with suprarenal preparations, as it does not constrict arterioles, but rather causes hyperemia. It ranks as a fair substitute for cocaine in from 2 to 5 per cent. solutions, either for direct application to mucous membranes or for hypodermic use. In 1 per cent. strength it may be substituted for cocaine in the solutions for infiltration anesthesia.

Nirvanin (not official).—This occurs in crystalline or powder form, soluble in water and in alcohol, the aqueous solution being neutral and claimed to be germicidal in 1 per cent. strength. It is used in from 1 to 5 per cent. solutions, though it should be used with care, as it is reported to be seven-tenths as toxic as cocaine.

Novocaine (U.S.P., Part II [$C_{13}H_{20}O_2N_2.HCl$]).—This drug has proved to be of such value as a local analgesic and substitute for cocaine as to merit a more extended description. It was discovered by Einhorn in 1905. It is a white powder, soluble in 1 part of water, the solution being neutral in reaction; soluble also in 30 parts of alcohol. A 10 per cent. aqueous solution is *neutral* to litmus. The aqueous solution, as usually employed, may be heated to the boiling-point without decomposition. It has the advantage of being non-irritating, since a solution of any strength, or even the powder, may be applied to the conjunctiva. It acts efficiently with suprarenal preparations, the effect being increased by the combination. Novocaine possesses the same action upon the peripheral sensory nerves as does cocaine, when directly applied to the nerve. The same is true of its use by injection and infiltration. However, by surface application, as to the cornea, its action is very much weaker than that of cocaine, but may be increased somewhat by the addition of sodium bocarbonate, according to Gros.*

Since novocaine is only one-half as toxic as cocaine, it may be used more freely, although the systemic effects of large doses are essentially the same as those of cocaine; but when used in the ordinary dosage there are no systemic effects. Five thousand injections in the extraction clinic of the Dental School of the University of Buffalo, using a 2 per cent. solution in normal saline, with small adrenalin dosage, have shown no systemic reaction in a single case, the ages ranging from childhood to old age.

Prinz† regards novocaine as the only one of these substances that meets the demands of substitution for cocaine. He cites evidence that its combination with adrenalin increases the efficiency of both drugs in their local action. He prefers a 2 per cent. solution and suggests the following:

Novocaine,	10 grains
Sodium chloride,	4 "
Distilled water,	1 fluidounce.

Boil. To each syringeful (30 minims) add 2 drops of adrenalin chloride solution when used.

Incompatibility.—Novocain in solution is incompatible with solution of *mercuric chloride* and with solution of *iodine*, a precipitate occurring with each. Mixed with *calomel* in equal parts, the mixture blackens when moistened with diluted alcohol. [It is *not* precipitated by *borax*

* Jour. Am. Med. Assn., January 26, 1918, p. 218.

† Dental Cosmos, September, 1908, p. 932.

nor by *potassium iodide,* as are cocaine hydrochloride, alypin and stovaine.]

Stovaine (not official).—Occurs in small scales, soluble in 2 parts of water and readily in alcohol. It is two-thirds as toxic as cocaine, but much more irritating. In recent years it has been brought into prominence through its use in spinal anesthesia.

Tropacocaine (not official).—An alkaloid from the leaves of Java coca, prepared also synthetically. It occurs in colorless crystals, soluble in water. It ranks well in efficiency, is one-half as toxic as cocaine, but is more irritating. It has the disadvantage of not acting efficiently with suprarenal preparations, since it destroys the vasoconstrictor action of the latter.

Orthoform (U.S.P., Part II [$C_8H_9O_3N$]).—A white, tasteless powder, sparingly soluble in water, but soluble in about 5 parts of alcohol and in 50 parts of ether; also soluble in sodium hydroxide solution. This drug is non-toxic in usual dosage, and, on account of its slight solubility in water, it has practically no penetrating power, therefore is useful only for surface action. It is not a substitute for cocaine in the usual use of the latter by injection, but it holds an important place for prolonged surface action, as in painful ulcers and, in dentistry, applied to a painful tooth socket after extraction. After operations upon the mouth or throat its application in powder form will greatly lessen the pain of movement or friction. It has been used internally to relieve the pain of gastric ulcer, the internal dose being from 2 to 15 grains (0.12–1 Gm.). Used in tablet form to be slowly dissolved in the mouth, it will often give much relief in cases of sore-throat. The *hydrochloride of orthoform** is said to be soluble in 10 parts of water, the solution being acid in reaction, and having the same action, dosage and uses as orthoform.

Incompatibility.—Orthoform is generally used alone. It is incompatible with *silver nitrate, potassium permanganate* and with *zinc chloride.*

Quinine and Urea Hydrochloride occurs in colorless crystals or as a white granular powder, odorless and bitter to the taste. It is soluble in 0.9 part of water and in 2.4 parts of alcohol. The aqueous solution is acid in reaction. This agent is comparatively non-toxic, the internal dose being 15 grains (1 Gm.). It is about one-fourth as efficient as cocaine when injected into the tissues; however, it has the unique advantage of producing a more lasting effect—from several hours to several days. Accordingly, it is often used for continued effect, in con-

* National Dispensatory, 3d ed., p. 1020.

nection with a more powerful analgesic, in order that the pain after operation may be lessened and the use of opiates averted. A 1 per cent. solution is commonly employed.

COMPARISONS OF COCAINE AND ITS SUBSTITUTES.—The essential requirements of a satisfactory substitute for cocaine are as follows:

1. It should be less toxic than cocaine.
2. It should be soluble in water.
3. It should not be irritating to the tissues.
4. It should be compatible with suprarenal preparations.
5. It should admit of sterilization by boiling.

1–2.—Four of the drugs described fulfil conditions *one* and *two*, viz.:

Stovaine.
Novocaine.
Tropococaine.
Beta-eucaine.

3. A comparison in regard to the *third* condition shows the following results when injected subcutaneously into the abdomen of the rabbit.*

Cocaine.—Swelling and hyperemia soon after injection, with complete return of the area to normal.

Stovaine.—Intense hyperemia, dilatation of bloodvessels followed by sloughing.

Beta-eucaine.—Swelling about the site followed by sloughing.

Tropococaine.—Swelling followed by sloughing.

Novocaine.—No swelling, no hyperemia, part normal after injection and remained so.

4–5.—Novocaine also fulfills conditions *four* and *five* and thus is the only one of the substitutes which fulfills all of the essential requirements for a local anesthetic. Indeed it may be said that this drug is an ideal local anesthetic for use in dentistry.

TOXICITY.—The following comparative table of toxicity of cocaine and its substitutes is of interest. It is based upon the minimum quantities causing death in frogs, mice and rabbits, the drugs being named in the order of their toxic effects.†

Frogs.	Mice.	Rabbits.
Alypin.	Alypin.	Alypin.
Cocaine.	Cocaine.	Cocaine.
Stovaine.	Nirvanin.	Stovaine.
Nirvanin.	Stovaine.	Tropococaine.
Beta-eucaine Lactate.	Novocaine.	Novocaine.
Tropococaine.	Tropococaine.	Beta-eucaine Lactate.
Novocaine.	Beta-eucaine Lactate.	

* Le Brocq, British Med. Jour., March 27, 1909, p. 783. † Ibid.

Taking the action on mammals into consideration, *i. e.*, paralysis of nerve centers (including respiratory) the following results have been shown:

Toxicity of cocaine is	1.00
" alypin is	1.25
" nirvanin is	0.714
" stovaine is	0.625
" tropococaine is	0.500
" novocaine is	0.490
" beta-eucaine is	0.414

EFFICIENCY.—Sollmann* has investigated local analgesics in reference to their efficiency both by surface application and by injection into the tissues. The practical results of his observations may be thus tabulated, showing the ratio of efficiency with cocaine as the unit:

Analgesic Effect upon Sensory Nerves Compared.

By surface application (to cornea).	Ratio.	By intracutaneous use (infiltration and injection).	Ratio.
Cocaine hydrochloride	1	Cocaine hydrochloride	1
Beta-eucaine hydrochloride	$\frac{1}{2}$	Novocaine hydrochloride	1
Tropococaine	$\frac{1}{4}$	Tropococaine hydrochloride	1
Alypin	$\frac{1}{4}$	Alypin hydrochloride	1
Quinine and urea hydrochloride	$\frac{1}{4}$	Beta-eucaine hydrochloride	$\frac{1}{2}$
Apothesin hydrochloride	$\frac{1}{5}$	Quinine and urea hydrochloride	$\frac{1}{4}$
Novocaine hydrochloride	$\frac{1}{16}$	Apothesin	$\frac{1}{5}$

A fact worthy of note in the above comparison is the very low efficiency of novocaine when applied upon the surface (to the cornea), as compared with its high efficiency when injected. It was found, however, that the addition of sodium bicarbonate increased the efficiency of novocaine, as also of the other agents, for surface effect. To state the matter definitely: If the anesthetic is made up "in double concentration, and diluted, just before use, with an equal volume of 0.5 per cent. sodium bicarbonate solution, this increases the efficiency (for the cornea) as follows: Cocaine, from one to two times; beta-eucaine, two times; novocaine, from two to four times; tropococaine or alypin, four times." *It must be emphasized that this result does not obtain with injection or infiltration uses of the drugs, but only with surface application.* Another point arrived at by Sollmann† is that the suprarenal preparations, combined with the local anesthetic, while very valuable to prolong the period of anesthesia when the mixture is injected into the tis-

* Jour. Am. Med. Assn., January 26, 1918, p. 216.

† Ibid.

sues, is useless for surface application—in fact, "it rather diminishes the penetration and therefore the efficiency of the anesthetics on mucous membranes (cornea)."

Spinal Cocainization.—Among the methods of inducing analgesia, that of injecting a solution of cocaine (0.2 to 0.5 per cent. strength) into the spinal canal has been employed, having been first advocated by Dr. Corning, of New York. By this means all parts of the body below the point of injection may have sensation to pain abolished, so that it is possible to do even an extensive surgical operation by aid of this method.

There are dangers attending this procedure, and its limitations have become recognized. When employed, the injection should be made as low down as possible, so as to avoid the effect of the drug upon the medulla. The method for the present should be used only in those cases where a general anesthetic is contra-indicated, and where the site of injection may be at a point some distance from the medulla.

PART III.

GENERAL REMEDIES.

CHAPTER XIV.

ANESTHETICS.

A TOPIC of so great importance as that of general anesthesia merits brief historical references as to agents employed and their discoverers.* **Ethylic ether**, formerly called "sulphuric ether," and, still earlier, "sweet oil of vitriol," was known as early as the thirteenth century, but the name of its discoverer is unknown. While it was used for some medicinal purposes in the eighteenth century and probably earlier, and although its intoxicating and narcotic properties had been discovered, it was not employed for practical anesthesia until 1842. During several years it was put to successful practical tests by Crawford Long, of Georgia, by Horace Wells, of Vermont, and by William T. G. Morton, of Boston, the last-named having demonstrated its use in a public way in Dr. Warren's clinic at the Massachusetts General Hospital, October 16, 1846.

With the discovery of **chloroform** four names must be associated: Guthrie, of Sackett's Harbor, N. Y., who is credited with its first discovery (1831); Liebig, of Germany, and Soubeiran, of France, who were close contemporaries with Guthrie in its recognition, and Dumas, who made known its composition in 1835 and gave it its present name. In 1847 it was introduced as an anesthetic by Simpson, of Great Britain, a physician of great prominence, who at once began to use it extensively in his practice.

Nitrous oxide also was known for many years before it came to be practically applied as an anesthetic. It was first obtained by Priestly in 1772. In 1799 Humphry Davy, of England, observed the exhilarating and intoxicating effects caused by inhaling this gas, and published his

* For a fuller discussion of the history of anesthesia, see Park's Epitome of the History of Medicine.

investigations in 1800. The credit for its first use as a surgical anesthetic belongs to Horace Wells, who employed it in 1844 for the extraction of a tooth.

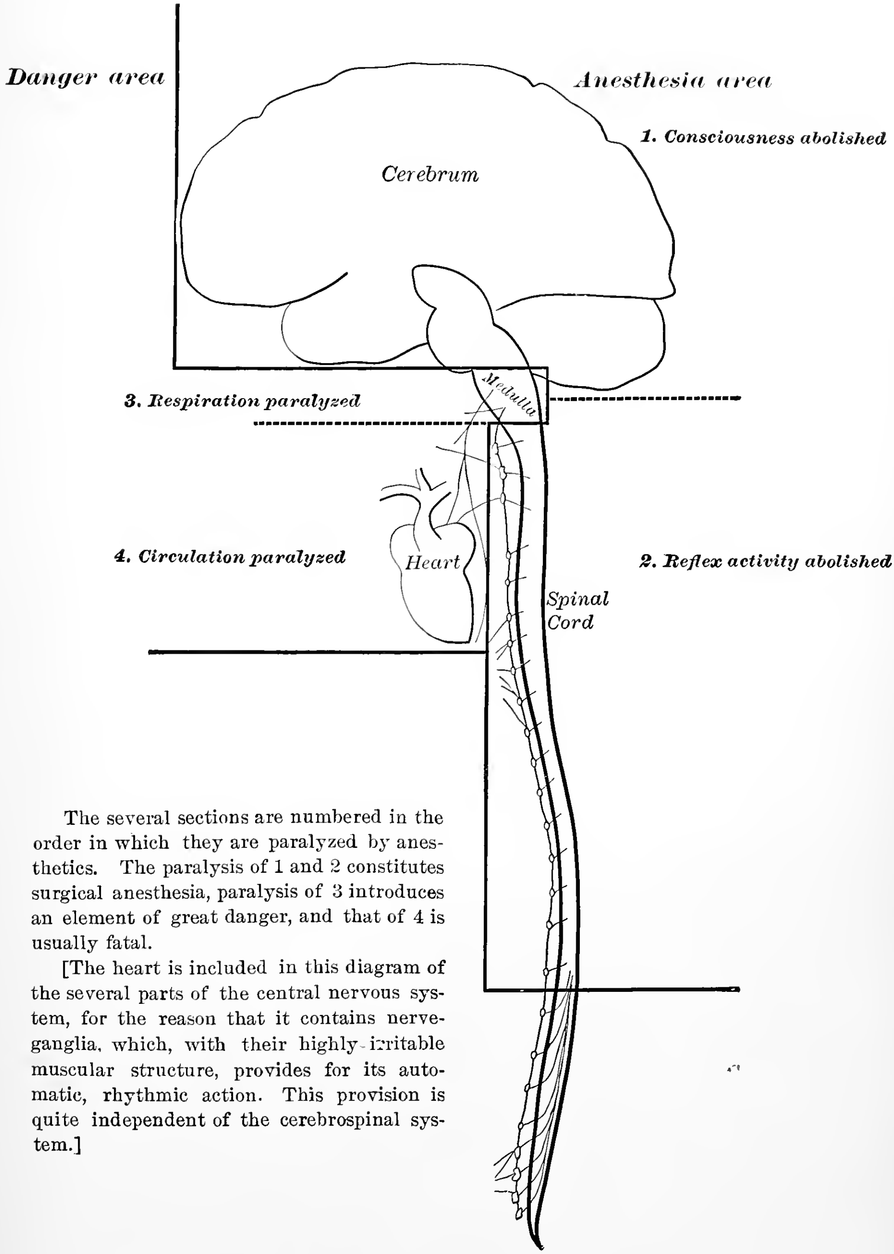
The condition of *general anesthesia* must include more than the abolition of consciousness to pain, the removal of unconscious muscular activity being only secondary in importance. In many cases a comparatively small amount of an anesthetic will suffice to abolish consciousness of pain, but muscular rigidity or activity will prevent the performance of a surgical operation. The term *partial anesthesia* is sometimes applied to a grade of effect where the cerebrum is paralyzed, with loss of *conscious* sensation, but where the reflex centers of the spinal cord are still sensitive, as shown by muscular activity whenever sensory nerves are irritated.

In studying these agents we also recognize the possibility of securing a purely *analgesic* effect from smaller quantities than are required for anesthesia. This is particularly true of nitrous oxide, as will be shown later.

As a class the typical anesthetics are peculiar in respect to the order in which they paralyze the different parts of the nervous system. At first thought the production of complete paralysis of all parts of the body capable of responding to external stimuli, by the administration of a substance foreign to the body, would seem to be an extremely dangerous procedure; and so it appeared until it was ascertained that the paralysis was induced in such order that the centers of consciousness were affected first and those whose activity is absolutely essential to life last. Any agent, therefore, to rank safely among this class of drugs must conform in action strictly to the lines of safety which have now become well established. Plate V. presents a division of the central nervous system into sections, which are numbered in the order in which they are paralyzed by anesthetics. It will be seen that the most highly developed, or differentiated, nerve tissue (brain) is first affected, while the simpler and more vital structures that are common to all forms of animal existence (those connected with the functions of respiration and circulation) are affected later, being apparently more resistant to the influence of the drugs of this class.

It is remarkable that these century-old agents have never been supplanted by newer anesthetics. The past few decades, that have yielded so much in the way of synthetic drugs, have not given us new general anesthetics, but have been devoted to a closer study of the old, as to their precise action, their dangers, and better methods of administration. That this has been a fruitful study is evidenced, among other things,

PLATE V.



The several sections are numbered in the order in which they are paralyzed by anesthetics. The paralysis of 1 and 2 constitutes surgical anesthesia, paralysis of 3 introduces an element of great danger, and that of 4 is usually fatal.

[The heart is included in this diagram of the several parts of the central nervous system, for the reason that it contains nerve-ganglia, which, with their highly irritable muscular structure, provides for its automatic, rhythmic action. This provision is quite independent of the cerebrospinal system.]

by the adaptation of nitrous oxide to the field of general surgery, where it is now used so largely with satisfaction and safety. Another result is that the science of anesthetics has been so developed that now very few cases occur that cannot be safely anesthetized by an expert using the proper agent. It may be added also that the judicious use of other narcotics with the anesthetic, in order to render the narcosis more profound and to lessen shock, has become more and more a routine practice. This is particularly true of the hypodermic use of morphine (sometimes with scopolamine) preliminary to prolonged nitrous-oxide-oxygen anesthesia.

Mode of Action of Anesthetics.—Various theories have from time to time been proposed to explain the mode of *action of anesthetics*, by ascribing their effects to action upon the blood, to alteration of the circulation within the brain, and to asphyxia; but the present belief is that these substances produce their effects chiefly by a direct action upon the nerve centers.

As to the precise action of the anesthetic upon nerve cells, it has been observed that the volatile liquid anesthetics are fat solvents; and the investigations of Meyer and Overton led them, independently, to the conclusion that anesthesia is caused by the solution of the lipoid constituents of the cells by the absorbed anesthetic vapor. The fact of the transient influence accords with a belief in some such simple physical change as solution, which would obtain only while the vapor was present in sufficient quantity. This theory could hardly explain the action of nitrous oxide, a gas whose nature and properties differ so greatly from those of the other anesthetics. If a common action is to be found it must rest upon other facts.

Blood Changes Induced by Anesthetics.—A number of observers have studied the blood in reference to anesthesia and some positive conclusions have been set forth as to changes in the blood caused by anesthetics.

Upon Hemoglobin.—It is now generally recognized that the hemoglobin of the blood is diminished in varying degrees by these agents (by ether markedly and rapidly, by nitrous oxide slightly and transiently) and that any case having less than 60 per cent. of hemoglobin would be hazardous under ether, and probably under chloroform, which increases hemolysis as well.

Upon Blood Cells.—Casto,* in observations upon eight human subjects, found that: "The general tendency of the *erythrocytes* was to

* Am. Year Book of Anesthesia and Analgesia, 1915.

decrease during anesthesia, an average loss of 16 per cent. resulting from the cases studied." These results were confirmed in the main by experiments upon animals.

Upon Alkalinity of the Blood.—Acid products are increased in the tissues and blood during anesthesia, chiefly because of diminished oxidation. In prolonged anesthesia this may reduce the alkalinity of the blood to a serious degree. When there is muscular activity during partial anesthesia the natural production of acid is increased, and if cyanosis is present, indicating a great diminution of oxygen intake, the acidosis may be a factor of great danger, not simply during anesthesia, but afterward. Hemorrhage increases this danger, because a diminished circulation brings less oxygen to burn up the accumulated acid products. Thus, acidosis (or high concentration of hydrogen ions*) probably is the important factor in auto-intoxication that often follows surgical anesthesia, and which must be distinguished from surgical shock.

Upon Blood-pressure.—The tendency is for blood-pressure to diminish during anesthesia that is at all prolonged, but the effect varies according to the agent employed; with chloroform the fall usually begins by the end of fifteen minutes and rapidly reaches its minimum within a few minutes; with ether the fall does not usually begin under twenty minutes and is then very gradual, often continuing and reaching its minimum after the operation has been completed and the anesthetic removed; with nitrous-oxide-oxygen no change in blood-pressure attributable to the anesthetic is seen within two hours, and any fall occurring after longer administration has been found to disappear promptly upon removing the anesthetic.† Since nitrous oxide is reputed to raise blood-pressure, which may be true of the gas given undiluted because of the attendant asphyxia, the fact is worthy of emphasis that the mixture with oxygen does not show clinically any rise of blood-pressure.

Asphyxia.—The condition of *asphyxia* (which, in this relation, may be defined to be lack of a sufficient oxygen supply to the cells of the tissues), is, without question, a factor in anesthesia in cases where an agent is administered with a limited supply of air. It was formerly held by high authority that nitrous oxide anesthesia was due simply to asphyxia, but this has been disproved by the fact, now daily observed, that anesthesia is induced by nitrous oxide when mixed with sufficient oxygen to prevent asphyxia. It is simply a question of deprivation of oxygen, without which the cells cannot function; and it is only with the use of

* Casto, Am. Year Book of Anesthesia, 1915; Henderson, Ibid, p. 96.

† McKesson, Am. Year Book of Anesthesia, 1915, pp. 90–91.

nitrous oxide alone and of ether by the old, closed inhaler method, that we encounter asphyxia in any important degree. However, asphyxia is of primary importance in its causative relation to *auto-intoxication,* under which topic it will be further discussed.

Action of Anesthetics upon Nerve Cells.—While the precise action that determines the paralysis of function of nerve cells in the state of anesthesia has not been demonstrated, much light is thrown upon the question by Lillie in his comprehensive article on "The Physico-chemical Theory of Anesthesia,"* which details the researches of himself and others. Lillie defines anesthesia, in reference to all responsive tissues, as "*the phenomenon of reversible decrease of activity of responsiveness.*" He argues from the proposition that the response of cells to stimulation probably begins at the surface of the cell, *i. e.*, that surface changes, where the cell-wall (or "plasma membrane") must first meet the stimulating agent in the surrounding medium, are responsible for the activity that follows in the cell as whole. It is evident that anesthetics decrease temporarily the responsiveness of nerve cells, and it is reasonable to assume that the action begins at the surface where the anesthetic first reaches the cell. But whether the action consists of physical change of the fat-like (lipoid) constituents (Meyer and Overton), whether, by this or other change, oxidation is restrained, or whether the protein constituents are affected either physically or chemically, remains to be proved. Lillie believes that the action begins at the surface. To quote from his earlier-expressed view, "anesthetic action is due primarily to a modification of the plasma-membrane of the cells or irritable elements, of such a kind as to render these membranes more resistant toward agencies which under the usual conditions rapidly increase their permeability; cytolysis and stimulation, both of which depend on such increase of permeability, are hence checked or prevented . . . . this effect is produced by various salts, *e. g.*, of magnesium, and by ether and other lipoid-solvent anesthetics in certain, not too high, concentrations. . . . . It seems clear that for irritable tissues the state of the lipoids in the plasma-membrane largely determines the readiness with which changes of permeability—and of the dependent electrical polarization—are induced by external agencies." The essence of this theory seems to be that the anesthetic in some way lessens the permeability or the electrical conductivity of the cell surface, so that response to the usual stimuli is prevented.

* Am. Year Book of Anesthesia, 1915, pp. 1–30.

We may state, therefore, that present theories are variously characterized by (*a*) belief in physical change of the lipoids, (*b*) in decreased oxidation, and (*c*) in alteration of electric polarization upon the cell surface; also, that these theories deal more with the mechanism of induction than with the essential state of the narcotized cell.

Whatever theory is favored, it is evident that the phenomenon of anesthesia involves selective action, *i. e.*, certain nerve centers are affected before others. The usual order is for the *cerebral areas* to be affected *first*, the *spinal cord second*, while the *medullary centers* are affected *last*. In fact, any agent whose action does not exhibit this selective order cannot rank as a safe anesthetic, for the respiratory centers in the medulla must remain active during anesthesia of brain and spinal cord. A recognition of this order also furnishes an index as to danger or safety in the course of its inhalation. Plate V. will aid us in appreciating the stages through which the action of anesthetics may extend, the numbers 1 and 2 pertaining to essential and safe anesthesia, and 3 and 4 to the dangers of profound anesthesia.

Stages of Anesthesia.—Descriptions of the stages of anesthesia are sometimes so elaborate as to be confusing. The simple division of Cushny into three stages seems sufficient for ether and chloroform at least.

A. *Imperfect Consciousness.**—At the beginning the inhalation may be accompanied by a sense of suffocation, which is greater with ether than with chloroform and is seldom present with nitrous oxide.

The cerebrum is very quickly affected, with the production of various manifestations of disturbed or uncontrolled nerve function, such as incoherent talking, laughing or crying, indefinite muscular movements and holding of the breath. The pulse is not much influenced as a rule. Respiration is quite normal except for the influence of the early choking sensation when the anesthetic vapor is too concentrated.

The pupils are responsive to light and are apt to be dilated. The special senses may be disturbed. Coughing is occasionally present.

B. *Excitement.*—With consciousness completely abolished, the control of the lower part of the cerebrospinal system by the cerebrum is removed, and we see accordingly various manifestations of uncontrolled reflex activity. The centers here concerned are mostly situated in the spinal

* This stage is described by some authorities as the *stimulant stage*, but the stimulant effects noted are mainly reflex, while the real condition is one of depressed consciousness. There is frequently noticed quite early a very brief period of complete relaxation, during which a slight operation might be performed.

cord, which is the second division of the nervous system to be influenced by anesthetics. (See Plate V.) Being not yet depressed to any marked degree, the impulses that it originates without cerebral control may produce the most violent muscular action, which is likely to be most marked shortly before complete relaxation occurs.

This stage of excitement is more decided with ether than with chloroform, whose general depressant effect is early evident, or with nitrous oxide, whose action in every stage is transient. The pulse is not much altered. Respiration may be interrupted by rigidity of the respiratory muscles. The pupils are apt to be dilated during excitement. They are responsive to light as long as reflex irritability persists.

Increased secretion of tears, and of mucus in the upper respiratory and oral regions, occur. Vomiting occurs as a very unpleasant complication if the stomach contains any food, especially when ether is employed.

During this stage consciousness to pain is abolished, but, as a rule, surgical procedure is impracticable until complete relaxation occurs, with cessation of reflex excitement, which marks the beginning of complete anesthesia. Relaxation is generally accompanied by snoring inspirations due to vibration of the relaxed soft palate.

C. *Anesthesia.*—With the occurrence of complete anesthesia the whole muscular system is relaxed, sleep is profound and reflex activity is absent; in fact, there is temporary total paralysis of nervous and muscular systems, except those parts concerned with respiration and circulation. The pulse is not much altered in rate, but blood-pressure may be lessened (*vide ante*). Respiration is full and regular, as during profound sleep. The pupils are usually contracted and do not respond to light. The cornea is insensible to touch. The general appearance does not differ much from that of a person in a deep sleep. However, with ether the face is apt to be more flushed than with chloroform. With nitrous oxide given alone some degree of cyanosis occurs.

The Important Things to Watch during the administration of an anesthetic may be grouped as below:

First, as indicating the progress and degree of anesthesia:

(*a*) The activity of the reflexes.

(*b*) The degree of muscular resistance.

(*c*) The condition of the pupil of the eye.

As shown in Plate V, reflex activity persists after consciousness is lost, but disappears with surgical anesthesia. Therefore, as long as any response to irritation of a highly sensitive area occurs, and as long as

any muscular rigidity exists, we cannot say that the proper degree of anesthesia has been reached. The usual way of testing *reflex irritability* is by toching the cornea or conjunctiva of the eye with the finger, which should be clean. The reflexes of the eye being among the last to disappear, any response by a closing movement of the eyelids shows that irritability of reflex centers still persists, while absence of any response usually indicates that anesthesia is complete.

Muscular resistance is usually tested by raising the patient's arm to full length perpendicularly and allowing it to fall. Any slowness or interruption in its fall shows muscular response and indicates that anesthesia is not complete, while a sudden drop of the arm, as if paralyzed, shows complete muscular relaxation and indicates that anesthesia to a surgical degree has been secured.

Muscular resistance often persists after ordinary reflex response is lost. This is of special importance in dental operations, where it is frequently found that the jaws are rigidly closed when anesthesia seems complete. In such cases it is necessary to push the effect beyond the degree which might suffice for an operation upon an accessible surface, in order to secure relaxation of the jaws, unless a mouth-gag or a cork be used to keep the jaws apart during the whole period of inhalation.

Again, owing to the necessity of suspending inhalation of the anesthetic during the dental operation, as for extraction, it is advisable to push the administration to a profound degree, so that the effect may last during the brief operation. This is permissible with the safer anesthetics, which do not endanger the heart's action. It may be stated, however, that an operation may be completed even after reflex activity is again evident, provided that muscular resistance does not prevent; for if consciousness be still abolished the patient cannot interpret the surgical irritation as pain, and will remember nothing of the operation, even though some struggling may have occurred through reflex activity. Such a practice, however, is not permissible with chloroform, in fact is dangerous, as will be explained in discussion of that agent.

The *pupils* remain responsive to light so long as anesthesia is not complete, with a tendency to dilatation during the early stages, due to the excitement that is more or less evident. With complete anesthesia the pupils contract and become fixed, *i. e.*, they do not respond to light, and appear in all respects as they do during profound sleep. After complete anesthesia has been induced, dilatation of the pupil may mean either slight return of reflex activity, which will be accompanied by the eye reflex and may call for more anesthetic, or it may mean a paralysis,

which indicates a most serious depression of the nervous system that may be speedily fatal. The latter will be unaccompanied by any sign of reflex activity or of muscular resistance, but relaxation will be complete.

Second, as indicating danger, note should be taken of:

(*a*) The respiration.

(*b*) The pulse (with chloroform especially).

(*c*) The pupil.

It must be insisted upon that the *respiration* be watched closely throughout, for it has been shown that death by anesthetics is due, in the majority of cases, to *failure of respiration centrally*, by paralysis of the respiratory centers in the medulla. Early in the administration respiration may be interrupted by choking sensations, and after consciousness is lost there is often some stoppage due to reflex muscular action; with ether this may be so marked as to cause a considerable degree of cyanosis.

These interruptions are temporary, and as long as the pupils are responsive they need not occasion any alarm, for any stoppage of respiration before anesthesia is complete is not dangerous, except, that mechanical closure of the glottis by falling back of the tongue might occasion a continued stoppage, resulting in fatal asphyxia. This cause will be removed by drawing the tongue forward by forceps or a silk ligature passed through it, or by either of two simple procedures that are usually successful—turning the head to one side so as to allow the tongue to fall to the side, and drawing forcibly forward both angles of the lower jaw.

Whenever interruption of respiration has occurred reflexly or mechanically, the first succeeding inspiration is apt to be deep and forcible. With chloroform especially, care must be taken not to allow free access of the drug with this deep inspiration, for fear of suddenly poisoning the heart by too much or too concentrated vapor.

During complete anesthesia respiration is slow and regular as in normal sleep. It is most important to *watch the respiration* at this time. Any *irregularity* or *interruption* is a danger sign, and must require suspension of the inhalation, free access of air, and respiratory stimulants. If cessation has occurred, artificial respiration must be resorted to at once. To begin with, these measures may be instituted without regard to the pulse, for, with respiration paralyzed, the pulse may still be feebly perceptible, or the heart may be beating so feebly as to cause no pulse in the peripheral vessels. In either case the rapid elimination of the drug

by exhalation, and the free supply of oxygen by inhalation, are most urgently required.

The pulse tells us of the rapidity and rhythm of the heart's action and of the condition of arterial pressure. It may be felt at the wrist, but is very conveniently felt by the anesthetist at the temporal artery. Any excessive rapidity (say above 120 per minute) and, even more important, any *irregularity* or *marked weakness* of the pulse beats, should enlist attention. Rapidity and irregularity are necessarily due to conditions in the heart or its regulating mechanism, while weakness of the pulse may be due in part to low blood-pressure from relaxation of the arterioles. Stimulation of the circulation during anesthesia requires those agents that will maintain arterial pressure, and forbids the use of vasodilators which lower arterial pressure. The recumbent posture with head low must be maintained when the pulse is weak or irregular. With *ether*, the pulse seldom shows any danger symptoms, but remains quite normal throughout, except that in prolonged anesthesia arterial pressure is lessened. With *chloroform*, the direct depressant action of the drug upon the heart and vasomotor system is added to the general depression of anesthesia, and there is accordingly a weaker pulse, lowered arterial pressure, and less ability to regain the normal in case danger symptoms occur.

A sudden failure of the heart, even early, is sometimes observed with the administration of chloroform. This may be due either to cardiac disease which permits the organ to be easily overcome, or to too rapid or too concentrated inhalation of the vapor. The necessity impresses itself of watching the pulse carefully throughout the administration of chloroform. According to Levy there is less danger from overdose of chloroform than from intermittent administration. (*See under* Chloroform.)

The Pupils.—The danger symptom that may be presented by the pupils occurs only during profound anesthesia, and consists of dilatation. This may represent stimulation of the dilator center due to asphyxia,* but it has also been taken to mean a paralysis of the contractor fibers. It is possible that in different cases both explanations may find application. Paralysis would, of course, be regarded as the more serious condition. During profound anesthesia the pupil should be observed *very frequently*, and any dilatation not accompanied by response of reflexes should require suspension of the anesthetic and immediate attention to the patient's condition.

* Sollmann, Text-book of Pharmacology, 1901, p. 441.

Recovery from Anesthesia varies in time from a very few minutes after nitrous oxide and chloride of ethyl, to several hours after ether. The patient may pass through a stage of excitement similar to that preceding anesthesia, but less pronounced as a rule. Vomiting almost invariably occurs when much ether or chloroform has been used. After these drugs there is also a tendency to sleep, and normal consciousness may not be restored for several hours.

Contra-indications to Anesthetics.—In general, we may say that anemia, disease of brain, lungs, heart, bloodvessels or kidneys contra-indicate general anesthetics. But a general rule admits of many exceptions, and, therefore, with respect to this matter each case must be judged by itself. As to contra-indications to individual agents more definite statements can be made.

For Nitrous Oxide.—It is usually held that serious heart or lung affections, that will easily lead to embarrassment of respiration or circulation when the asphyxia accompanying the use of nitrous oxide is added, should prohibit the use of this gas; also that disease of the arterial walls to the point of weakening them, presents the danger of rupture under nitrous oxide. This statement is based upon the fact that asphyxia leads to contraction of arterioles, with increased blood-pressure in the smaller arteries. Apoplexy, from arterial rupture within the brain, would be the most serious result to be feared. These contra-indications may be largely removed by the combined administration of oxygen with the nitrous oxide.

For Chloroform.—In addition to the general statement above, we should note that disease of the heart muscle (myocarditis, myocardial degeneration or fatty degeneration) prohibits the use of chloroform. As this drug is capable of causing fatty degeneration of various organs, the structure of all circulatory and eliminative organs should be normal in order to admit of its use. Valvular disease of the heart, if well compensated, is less a contra-indication than is degeneration of the heart muscle as indicated by weakness, irregularity or dilatation. It has been shown by experiments upon cats, that the administration of adrenalin under light chloroform anesthesia is usually fatal. In the human subject also cases of death have occurred under similar conditions.* Suprarenal preparations, therefore, are positively contra-indicated in chloroform anesthesia.

For Ether.—The general contra-indications given above apply typically to ether, with discrimination as to any special case. It is to be noted

* Am. Year Book of Anesthesia, 1915, p. 118.

that ether has very little depressant action upon the heart; on the contrary, it diminishes the hemoglobin appreciably and would, accordingly, be contra-indicated in any case of anemia showing 60 per cent. or less of hemoglobin. On account of the comparatively large amount of ether required, it is believed by some to be particularly damaging to the eliminative organs, especially the lungs and kidneys, but it is probable that the effects here are less permanent and less serious than those produced by chloroform.*

While we should always give due place in our judgment to the general contra-indications previously stated, when any anesthetic is in question, yet, when we have mentioned the unpleasantness of ether inhalation, the excitement that it frequently causes, and the prolonged and uncomfortable period of recovery, we have made our chief complaints against ether. It stands first as a safe general anesthetic for profound and prolonged effect.

Auto-intoxication and Asphyxia.—One danger of anesthesia that has not been sufficiently recognized is that of auto-intoxication. Asphyxia is an important factor in causing this condition, as by the deficiency of oxygen the normal elaboration and final oxidation of tissue elements is interfered with; consequently elimination is deficient and acid waste products accumulate in the tissues. Also after chloroform and ethyl chloride (and other related chemical substances which yield a halogen acid, *e. g.*, ethyl bromide and ethyl iodide), degeneration of liver cells easily occurs as well as other tissue changes. There is a growing belief that auto-intoxications and fatty degeneration of organs in connection with anesthesia are due mainly to acid products. Lack of oxidation may be responsible in part for the accumulation of these, or one of the halogen acids may be liberated from certain anesthetics.† Cases of death occurring several days after the use of ether or chloroform, the immediate effect of the drug having been recovered from, are often due to auto-intoxication rather than to the particular anesthetic employed.

It is true that nitrous oxide anesthesia, as usually employed in dentistry, is so brief that the asphyxia that necessarily attends it because of the closed inhaler used, may be disregarded as of light importance; but its prolonged use now so common in general surgery, should be accompanied by inhalations of oxygen. While we may not insist upon the use of oxygen as routine practice in connection with anesthesia of moder-

* See conclusions of Committee of the British Medical Association, Lancet, London, 1901, vol. i, p. 280.

† Graham, Am. Year Book of Anesthesia, 1915, p. 150.

ate duration, it is certainly advisable in greatly prolonged anesthesia with any agent; and objection must be made to inhalers for ether, ethyl chloride, or chloroform that do not admit enough air for proper oxygenation of the blood. The practice of rebreathing the same gases during anesthesia also is to be discouraged, unless for short periods or under expert supervision. An expert will often employ rebreathing, but with sufficient pure oxygen to avoid asphyxia.

Preparation of Patient for Anesthesia.—For ordinary nitrous oxide anesthesia it is only necessary to be assured of the non-existence of serious disease in vital organs and in the arterial walls, and to observe the general precautions to be given later. For prolonged use of the same agent, similar preparation should be made as for ether and chloroform.

Before employing ether, chloroform or ethyl chloride, preparation should be made in order to avoid unpleasant or dangerous complications both during and after the administration. Except in emergencies that seldom occur in dental practice, an anesthetist is not justified in administering one of these agents without first ascertaining that no disease exists in heart, lungs, brain, bloodvessels and kidneys, nor any anemia, sufficient to constitute a contra-indication. It is essential to examine the patient's urine in every case. The blood-pressure should be taken as a rule, and the blood examined in any case that presents the appearance of anemia or chlorosis. [Less than 60 per cent. of hemoglobin should contra-indicate the use of ether, chloroform or ethyl chloride, but nitrous oxide may be used with care.]

To this routine is added the positive injunction to the patient to take nothing into the stomach for at least five hours before the operation is to occur. This will avoid vomiting during the administration. A free cathartic should be employed within the twenty-four hours preceding the operation, particularly if constipation is present.

An important precaution, that should invariably be taken if the patient be a woman, is to have a third party present, which in case of dental operations may preferably be a friend of the patient. A case is recorded where the imaginations of an anesthetized woman were such as to form the basis of a charge of criminal assault against the operator;* therefore one should guard against such an unfortunate possibility in any case of anesthesia under his direction.

Coming to the time of administration, any artificial denture or other

* Reese. Medical Jurisprudence and Toxicology, second edition, p. 559.

appliance must be removed from the mouth. When ether or chloroform is to be used it is well to protect the eyes from the irritating vapor by covering them with a towel. If the greatest care is not exercised as to quantity of liquid applied to the inhaler it may drop upon the face and irritate the skin. Some anesthetists protect the tissues about the mouth and nose by covering the skin and lips with a light application of sweet oil or vaseline. The patient must be informed of the probable unpleasantness of the vapor, so as not to be surprised by the sense of suffocation. The clothing about the neck, chest and waist should be sufficiently loose to allow of free respiratory movements, and the patient should finally be instructed to breathe deeply.

In case of emergency requiring an operation at night, ether must not be used in the presence of a gas flame or ordinary fire. The *vapor of ether is explosive.** It is also heavier than the air, and will fall to the floor and diffuse itself mainly in the lower part of the room. It may, therefore, reach an open fire at some distance in explosive strength, without being particularly evident in the upper part of the room. The only safe light to use about ether is the incandescent electric light, which is fully enclosed. For the same reason, it is necessary to observe some care in handling ether. It should be kept and handled in tin cans rather than in bottles, in order to avoid accidental breakage with diffusion of the explosive vapor.

Responsibility in the Use of Anesthetics.—With all precautions taken, it still remains a fact that occasional deaths attend the use of anesthetics. Therefore, the question of responsibility in their use becomes an important one. For slight operations, such as tooth extraction, that do not

* In order to ascertain the degree of explosiveness of ether vapor, a series of ten experiments were made by Government Chemist Albert P. Sy, M.S., at the Sandy Hook Proving Grounds, in March, 1904. The tests were made with mixtures of ether vapor and air in strong glass flasks, through which the electric spark was passed, explosion being evidenced by blowing out of the cork. In four of the experiments, with mixtures containing from 0.93 per cent. to 1.65 per cent. by volume of ether vapor, no explosion occurred; while the other six experiments, with mixtures containing from 1.67 per cent. to 2.39 per cent. by volume of ether vapor, were each attended by explosion. The minimum percentage attended by explosion was 1.67 by volume, which is the equivalent of 0.355 pound of ether vaporized in 100 cubic feet of air. Report of War Department, Chief of Ordnance, 1904, vol. x, p. 163.

These experiments would seem to indicate that in a room of 1000 cubic feet space (10 x 10 x 10 feet) anything less than 3.5 pounds of ether could be vaporized without danger of explosion. This degree of concentration would never occur with the ordinary use of ether as an anesthetic. The chief danger wou'd probably be in the irregular diffusion of the vapor by reason of its weight, allowing concentration in some part of the room near a flame.

absolutely require it, it is well to place the responsibility of deciding for an anesthetic upon the patient. With the decision made and the proper agent selected, it remains with the operator to bring to its administration the requisite knowledge and skill; and the dental practitioner must determine how far he will here assume the responsibility. It must be said that the dental curriculum of study does not provide sufficiently for training in physical diagnosis and general clinical work to fit the dental specialist for the office of anesthetist. It is doubtless proper for him to administer nitrous oxide, but to be prepared in all points that are involved in the use of ether and chloroform requires a broad medical training and considerable experience. The course that is most natural and that places the responsibility where it really belongs, is to refer the whole matter of general anesthesia in any case to the patient's own physician, both for decision as to the propriety of anesthesia and selection of the agent, and also for its administration and the general care of the patient. These suggestions are based upon an appreciation of what might be the result of an accidental death, where it was made evident that the anesthetic was employed without every reasonable precaution having been taken. Recent years have seen the development of the professional anesthetist, to whom we owe much of the progress evident in our knowledge of anesthetics and in improved methods of employment. It is customary now for a surgeon to have his own special anesthetist. In any case in which there is question as to the advisability of giving a general anesthetic, it is well to have the services of the expert in anesthesia who should, as a matter of course, have had a medical training.

Nitrogenii Monoxidum. Nitrous Oxide.—A gas having the formula N_2O, capable of being liquefied under pressure. It is colorless, having a slight odor and a sweetish taste. It is soluble in water and in alcohol. It is not combustible, but will support combustion.

This gas was formerly prepared by the practitioner for his own use, by heating ammonium nitrate in a retort to the point of decomposition. It was collected and stored for use in an ordinary gas tank over water. Care had to be exercised to avoid a degree of heat that would develop the higher, poisonous oxides of nitrogen. This method of home manufacture is now well-nigh obsolete, as the gas can be obtained in liquid form in cylinders of convenient size, and with greater assurance of purity.

Nitrous oxide is non-irritating when inhaled, and it has been abundantly proved to be the safest general anesthetic known. Its effects

upon vital structures are so slight and unimportant, and the duration of its main effect so brief, that in properly selected cases it should be absolutely safe. With the very few cases of reported death from inhalation of this gas, it may be questioned whether the results could be attributed entirely to it. It has been largely used to induce transient anesthesia for slight operations, its most extensive use having been for tooth extraction. At present it is also used in general surgery, and its use has been extended in two special ways, first, by its employment to secure anesthesia quickly, to be followed by ether, thus shortening the period and removing the unpleasantness of the early part of ether administration; and *second,* by its combined inhalation with oxygen, whereby the element of asphyxia is removed, permitting the anesthesia to be continued indefinitely. By this latter method nitrous oxide has been adopted by many surgeons as the anesthetic of choice in general surgery; and even for major operations it is largely used, always with oxygen, and supplemented by a small amount of ether in suitable cases.

Nitrous Oxide Analgesia.—A comparatively new use to which nitrous oxide is adapted is that of inducing analgesia, without loss of consciousness, for any desired time during the preparation of cavities in sensitive teeth. A nitrous-oxide-oxygen mixture is used, such as experience shows will maintain a state of analgesia without any asphyxia or loss of consciousness. The nasal inhaler must be employed. As a matter of course, experience will be needed to employ this method expertly, but it contributes to the facility of handling a class of hypersensitive cases greatly to the patient's comfort.

Complete Anesthesia may usually be induced by pure nitrous oxide in from two to five minutes, and recovery occurs in an equally short time. With the full effect obtained quickly, it is not so easy to define stages of action, but we may note about the same order of paralysis as with ether. The disturbance of consciousness is quite characteristic, in that the emotions are prominently affected, laughing being so often induced as to lead to the popular designation of the substance as "laughing gas." Reflex activity is likewise often evident, the patient sometimes even needing restraint. When the gas is given mixed with air, the excitement is apt to be greater and the anesthetic effect more slowly produced. The most striking feature of nitrous oxide anesthesia produced rapidly, is cyanosis due to the exclusion of oxygen—really *asphyxia.* It has been held by some that anesthesia by this agent is simply asphyxia; but, although asphyxia will induce unconsciousness, it is easily demonstrable that nitrous oxide has a specific anesthetic action, for, with a patient

fully under its influence, the addition of oxygen will remove the asphyxia without terminating the anesthesia, which will continue as long as nitrous oxide is administered.

Administration.—The routine way of employing nitrous oxide is by a closed inhaler, which may cover mouth and nose or nose only,

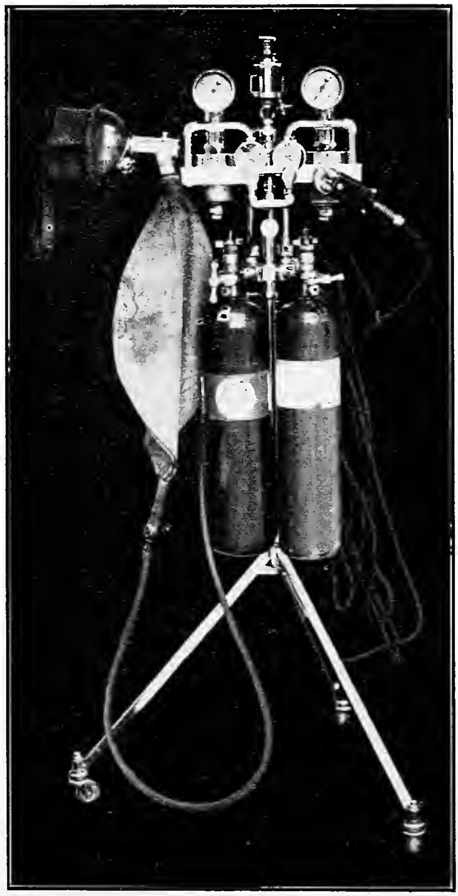


FIG. 7.—Luke's nitrous oxide apparatus. (Brewer.)

the latter for continued administration in operations about the mouth. The inhaler is of rubber, or of metal or celluloid with the edges applying to the face covered with a rubber air-cushion, so as to apply closely. Celluloid has the advantage of transparency. The part where the gas enters and the air of expiration escapes is usually of metal, while the tubes are of flexible material. For prolonged operations about

the mouth the pharyngeal method is often employed. Instead of the usual inhaler this method employs two small tubes which pass through the nostrils into the pharynx, thus leaving the face entirely uncovered.

As to the apparatus, the old gas tank of the dental office, for nitrous oxide alone, has been supplanted by several makes of portable apparatus arranged for combined use of N_2O and O, with means of easy regulation of the mixture. Some of these are sufficiently light and compact to be carried about when necessary. Such apparatus accommodates separate cylinders of N_2O and of O, with rubber gas bag to receive the mixture, while the regulating mechanism permits the use of pure N_2O or any desired mixture, or pure O if emergency requires.

Advantages of Nitrous Oxide.—A summary of the points that give to N_2O the place of preference is as follows:

1. Being non-irritating, its inhalation gives no discomfort.

2. Anesthesia is induced quickly and recovery follows quickly, without unpleasant after-effects.

3. It has very little effect either upon the blood elements (hemoglobin or blood cells) or upon blood-pressure.

4. It does not depress the heart to any appreciable degree.

5. Its contra-indications and dangers are practically removed by the addition of oxygen.

6. Used with sufficient oxygen, its employment may be greatly prolonged, with a minimum of auto-intoxication.

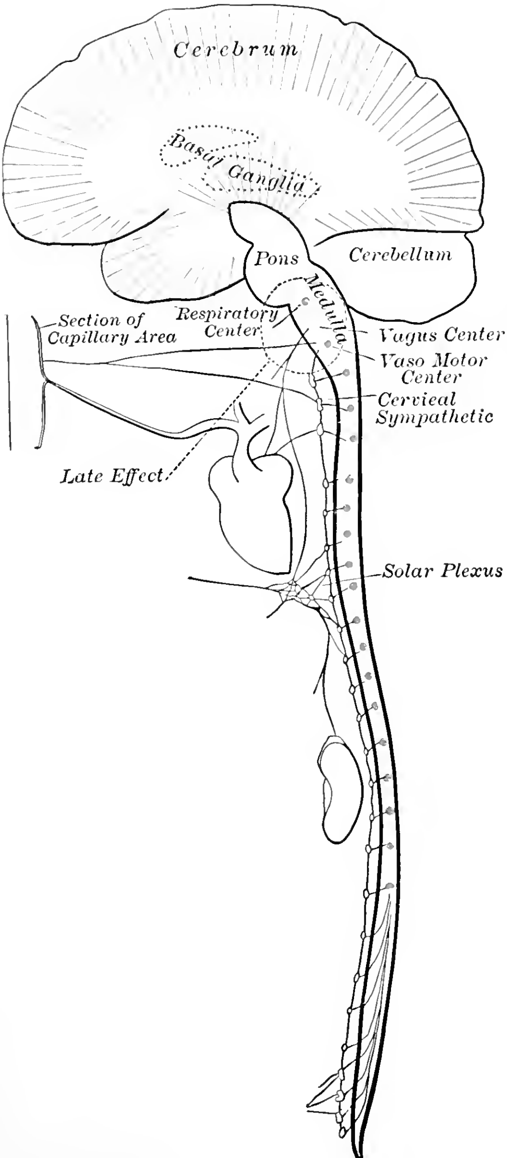
7. It permits the addition of ether vapor when a more profound effect is needed.

8. It is a practical general analgesic when the abolition of painful sensation is the only essential.

Æther.—Ether.—*Ethylic Ether.*—Composed of 96.5 per cent. of ethyl oxide $[(C_2H_5)_2O]$ and 3.5 per cent. of alcohol; prepared by the action of sulphuric acid upon alcohol, hence sometimes called "sulphuric" ether. It is a light, colorless, volatile liquid, with a penetrating odor and disagreeable, burning taste, having a specific gravity of 0.713 to 0.716 at 25° C. (77° F.). Its vapor is about $2\frac{1}{2}$ times heavier than air, and may be explosive when mixed with air and brought into contact with a flame. It is soluble in about 12 times its volume of water, and is miscible with alcohol, chloroform and oils. Average internal dose, ♏ 15 (1 mil).

Ether boils at about 35° C. (95° F.). One test of its strength is that, in a test-tube half-filled and containing fragments of broken glass, it should boil by the heat of the hand, when the tube is closely grasped and held for some time. The vapor being explosive, ether should be

PLATE VI.



The blue color indicates depression caused by ether.

ÆTHER.

Stimulant. Anodyne.
Anesthetic.

The action of these two substances is ve
which th

Ph

Ether, in the concentrated form which it is administered, is more irritating than chloroform, therefore the primary reflex stimulation and the late excitement are much more pronounced. It may cause danger by paralysis of respiration, but the heart is depressed so slightly that recovery may usually be secured.

Locally applied, the drug is an irritan

Nervous System.

Brain. Depresses cerebrum, abolishing all of its functions.

Medulla. Of the whole central nervous system the medulla is affected last. In dangerous narcosis the respiratory and vasomotor centers are paralyzed.

Spinal cord. Abolishes all functions, the sensory side being paralyzed before the motor.

Circulation.

Not much altered from the normal until anesthesia is profound, when arterial pressure is diminished.

Heart. Early may show reflex stimulation. Later not much affected unless administration is prolonged when some depression may occur.

Capillary area. Some dilatation of cutaneous arterioles usually occurs with flushing of the face.

Eye. Early the pupils are dilated. During complete anesthesia they are contracted. With dangerous paralysis they dilate.

Respiration. May be irregular or interrupted during partial anesthesia. During full anesthesia it is regular and normal, as during sleep. dangerous narcosis it fails, through paralysis of the respiratory center

Temperature is reduced during anesthes

Metabolism. Influence is usually slight and transient. The drug is eliminated chiefly by the lungs.

PLATE VII.

CHLOROFORMUM.

ssified as :

Irritant. Anodyne.
Anesthetic. Antispasmodic.

imilar, the main differences being in the degree in ffect various organs.

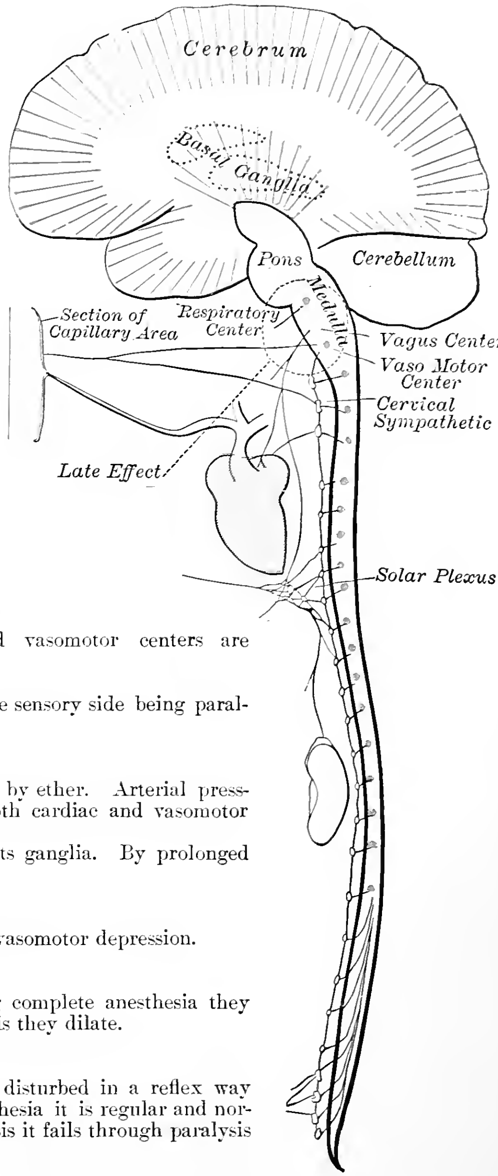
.ogic action :

Chloroform is pleasanter to inhale, but much more depressant to nerve centers and heart.

According to Cushny, it is 3 to 3½ times as depressant to the central nervous system, and 25 to 30 times as depressant to the heart, as is ether.

It usually causes death by paralysis of respiration, the heart continuing to beat, though so greatly depressed as to prevent recovery in many cases. However, it is believed by many that the heart may in some cases be paralyzed first. This is probably true in cases of degeneration of the heart.

Locally applied, the drug is an irritant, especially when the vapor is confined, as in the production of a "thimble blister."



Nervous System.

Brain. Depresses the cerebrum, abolishing all of its functions.

Medulla. Of the whole central nervous system the medulla is affected last. In dangerous narcosis the respiratory and vasomotor centers are paralyzed.

Spinal cord. Abolishes all functions, the sensory side being paralyzed before the motor.

Circulation.

Much more depressed by chloroform than by ether. Arterial pressure decidedly diminished, probably by both cardiac and vasomotor depression.

Heart. Depresses the heart muscle or its ganglia. By prolonged action may cause fatty degeneration.

Capillary area. Arterioles relaxed by vasomotor depression.

Eye. Early the pupils are dilated. During complete anesthesia they are contracted. With dangerous paralysis they dilate.

Respiration. During partial anesthesia it is disturbed in a reflex way less than with ether. During full anesthesia it is regular and normal as during sleep. In dangerous narcosis it fails through paralysis of the respiratory center.

The blue color indicates depression caused by chloroform.

Temperature is reduced during anesthesia.

Metabolism. Destruction of proteids is increased with less perfect oxidation. Fatty degeneration of heart, liver and kidneys may occur. The drug is eliminated chiefly by the lungs, but it has been found in the urine.

kept in tin cans so as to avoid danger of breakage with rapid diffusion of the vapor.*

Plate VI represents the action of ether upon the central nervous system, the respiration and the circulation. (For preparations see Index of Drugs.)

General Uses.—When applied to the skin the rapid evaporation of ether causes a decided cooling of the surface; applied to the mucous membrane it is irritating. The stimulant use of ether preparations depends largely upon this irritant quality. The spirit and compound spirit are employed in moderate doses as *stimulants*, the effect being reflex from local irritation of the mucous membrane. In large doses these preparations are *anodyne* after absorption.

Ether is also a valuable solvent for resins, oils, iodoform and many other substances not readily soluble in water.

As an Anesthetic.—Since its introduction, three-fourths of a century ago, ether has stood as our typical anesthetic, combining efficiency with a high degree of safety, and applicable in nearly all conditions requiring a general anesthetic. With a recognition of the greater dangers of chloroform, ether came to be accepted as the routine agent in general surgery. But in more recent years, the development of nitrous-oxide-oxygen anesthesia has given advantages that have led to its use instead of ether to a considerable extent; but even this newer method must rely upon ether as an addition in many cases, for profound anesthesia. So we may say that ether holds its place of primacy, while chloroform has fallen to a status of very restricted use.

Administration.—It has long been held that the inspired air may be fully saturated with ether vapor and thus inhaled for a considerable period with safety; more than this, the older methods of etherization employed a nearly closed inhaler into which ether was poured by the one-quarter to one-half ounce at intervals. This demonstrated clinically that ether could be given with a limited supply of air supersaturated with ether vapor. This evidence of the safety of ether led to indifference as to method of its use, so that the giving of ether was oftentimes assigned to a junior hospital interne, or to an undergraduate with no training or experience in anesthesia. But that has all been changed with the recognition of experts in anesthesia, so that the surgeon now wants his special anesthetist or, at least, a person trained or experienced. The result is that, with the knowledge of grave dangers incidental to pro-

* Regarding the degree of explosiveness of ether vapor, see note, p. 198.

longed narcosis even with ether, great care is now taken as to the method of giving and amount given; for it is a cardinal point that the greater the amount introduced in a given time the more profound the narcosis, and the greater the interference with oxidation in the cell, and the occurrence of acid intoxication.

Present-day methods of administering ether are safer, pleasanter and more economical. The old cone inhaler has been largely supplanted by

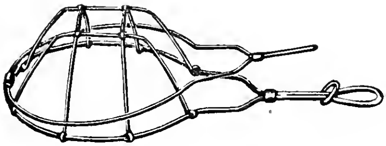


Fig. 8.—Sander's mask.

inhalers of various makes, all of which secure a more perfect vaporization and more definite admixture with the inspired air. They allow free access of air, and the ether is added drop by drop instead of being poured in in bulk.

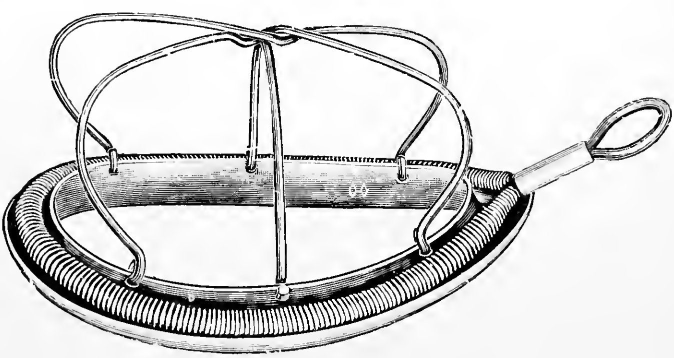


Fig. 9.—Yankauer's folding mask

The simplest form of open inhaler is the Esmarch (see Fig. 10), or some modification of it, so commonly used with chloroform. Similar to this, but adapted to the drop method for ether by being made to fit more closely to the face, inhalers such as are shown above are much used. The gauze covering is easily added for each administration.

Other forms of apparatus present some refinements of method, but are less simple and pertain rather to the specialist in anesthesia.

For the use of ether alone by the semi-open-drop method, the Ferguson double-chamber inhaler is typical.

The double chamber supplies a space in which the vapor is warmed to some degree by the expired air, so that vaporization is facilitated and the mixture is less cool for inspiration—a point to be considered in prolonged anesthesia. This inhaler, covered with about 8 layers of gauze, allows an ether vapor percentage varying from 6 to 22 per cent., the average of which (12 to 15 per cent.) would represent the usual desired dilution. [15 to 30 per cent. is needed for induction, but the lower percentages suffice to maintain anesthesia.]

The disadvantages of ether commonly experienced are two—*first,* the unpleasantness of the vapor, which will cause a sensation of irritation and suffocation if not skilfully given; and *second,* nausea and headache following the narcosis. The first can be met by inducing slight anesthesia with nitrous oxide or ethyl chloride, changing to ether when the sensations are benumbed; or a few drops of oil of orange preceding the ether will sufficiently mask its odor, if the latter is then given slowly at the start. However, there is usually no difficulty if the patient is instructed and reassured in advance and the ether given slowly and with plenty of air at first. More difficulty is experienced with children before the age of coöperation, so that the preliminary use of ethyl chloride or nitrous oxide may be advisable; though much can be done with a sensible child through reassurance and the use of the pleasant oil of orange at first.

The second disadvantage, nausea and headache following, cannot be met so easily. These symptoms belong to intoxication by narcotics generally, *e. g.*, morphine and alcohol, and little can be done to mitigate them, except to limit the amount of drug used.

Chloroformum.—Chloroform [$CHCl_3$].—This substance is prepared by the action of chlorine with an alkali upon alcohol, and is composed of 99 to 99.4 per cent. by weight of absolute chloroform and 1 to 0.6 per cent. of alcohol. It is a heavy, colorless, volatile liquid, with an ethereal odor and sweet, burning taste, having a specific gravity of not less than 1.474 at 25° C. (77° F.). It is soluble in 210 volumes of cold water and freely in alcohol, ether, benzin, benzol and the fixed and volatile oils. Chloroform should be kept in dark-colored bottles in a cool and dark place. It is not inflammable, but its heated vapor will burn with a green flame. Average internal dose, ♏ 5 (0.30 mil.).

Preparations:

Aquæ chloroformi (about 0.5 per cent.). f℥4 (15 mils.).
Spiritus chloroformi (6 per cent.), ♏ 30 (2 mils.).
Linimentum chloroformi (30 per cent.), external use.

Plate VII represents the action of chloroform upon the central nervous system, the respiration and the circulation.

Aside from its use as an anesthetic, chloroform has *general uses* as follows:

As Anodyne.—Toothache may frequently be relieved by placing a loose pledget of cotton saturated with chloroform between the cheek and the alveolus of the affected tooth.

In gastric or intestinal colic the drug may be given in a dose of 5–15 ♏ (0.30–1 mil.), dropped upon sugar or mixed with a fixed oil.

In paroxysms of severe pain it may be inhaled cautiously; in labor, to lessen the severity of the pains during the expulsive period. Its use as an anodyne calls for discretion and the avoidance of every possibility of overdosage. It should always be given by a physician or under his direction, for it is not safe for a person to inhale this drug by his own administration.

As Antispasmodic.—To relieve infantile convulsions, acute paroxysms of asthma, uremic and puerperal convulsions. In these conditions it should never be employed except with competent medical supervision.

As Irritant.—It may be used as a counterirritant in case of neuralgia or other localized pain. The effect will vary from mild irritation to the production of a blister, according to duration of the application. If the vapor be completely confined, as by placing the drug upon cotton and covering with a thimble, a small blister ("thimble blister") is quickly produced.

As Solvent.—Chloroform is used as a solvent for oils, some resins, caoutchouc, gutta-percha, etc.

As an Anesthetic, in spite of its long history and earlier extensive use, chloroform today holds a secondary place, because of its dangers. It is much pleasanter to inhale than is ether and a smaller quantity is required, which advantages make it the agent of choice with young children, who seem to be less susceptible to its poisonous action. But the prevailing opinion today is that the use of chloroform with adults is hardly justifiable, except in selected cases. The danger from this agent depends upon its poisonous action upon the heart.

Two facts furnish the basis of this danger:

1. It has long been held that chloroform is a direct heart poison, depressing its action greatly and being capable of causing fatty degeneration of its structure. These effects are probably in direct proportion to the amount or concentration of the drug.

2. Recent studies have shown that under certain conditions, chloro-

form even in small amount affects the heart peculiarly,* rendering it irritable to accelerator impressions in a way that may cause irregularity, fibrillation and sudden death. This effect is not likely to occur during complete anesthesia, when exciting impulses are blocked.

Here we have a new explanation of the cases of sudden death under chloroform, that occur when least expected and apparently unprovoked, *i. e.*, before anesthesia is complete or during recovery from the anesthesia. Intermittent administration has also proved dangerous. Levy† concludes that the "subject of light chloroform anesthesia requires very serious attention" and as a precaution "the first principles are to keep the patient *fully anesthetized* and to make the *administration continuous*." He argues against the idea of overdosage in these cases and advocates the use of higher percentages, temporarily, when necessary (3.5 to 4 per cent. of chloroform vapor). There should be no disturbance of the patient during induction of, or during recovery from, chloroform anesthesia and the operation should not begin until anesthesia is complete. To make an incision with reflexes active is considered hazardous.

Administration—The conclusion is clear that the use of chloroform should not be resorted to lightly and that, when employed, administration should be by an expert. Because of its depressant effect upon the heart, it should be given only with patient in the recumbent posture. This being usually impossible in dental operations furnishes additional reason for its non-employment.

Chloroform should be given largely diluted with air, from an inhaler that cannot fit closely enough to exclude air. A convenient and simple one consists of a wire form four inches in diameter with a concavity to prevent contact with the nose. This is covered with a few layers of gauze, upon which the chloroform is dropped in small quantities (ten to twelve drops) frequently, or drop by drop more continuously (see Fig. 7).

* It has been found that under chloroform anesthesia the heart exhibits an *irritability* which may respond to certain exciting causes in a most peculiar way, *e. g.*, experiments upon cats under chloroform showed a remarkable development of irregularity of ventricles upon intravenous injection of adrenalin. The ventricles beat rapidly and irregularly, exhibiting the condition known as *ventricular fibrillation*. This action is more intense if the chloroform is diminished so as to allow the corneal reflex to return, and the result then is usually fatal, the heart stopping suddenly after a period of irregularity. It is believed that accelerator impulses, from the central nervous system or reflexly through irritation of sensory nerves, may similarly influence the heart under chloroform. This would account for the cases of sudden death occurring early in the administration of chloroform. Levy, "Cardiac Fibrillation and Chloroform Syncope," Am. Year Book of Anesthesia, 1915.

† Ibid., p. 130.

The inspired air should not usually contain more than 2 per cent. of the vapor of chloroform. This is in accordance with the conclusions of the Special British Chloroform Committee,* to the effect that 1 to 2 per cent. of chloroform in the air is sufficient for anesthesia, and that these proportions are safe; 0.5 per cent. is inefficient, while 5 per cent. is dangerous.

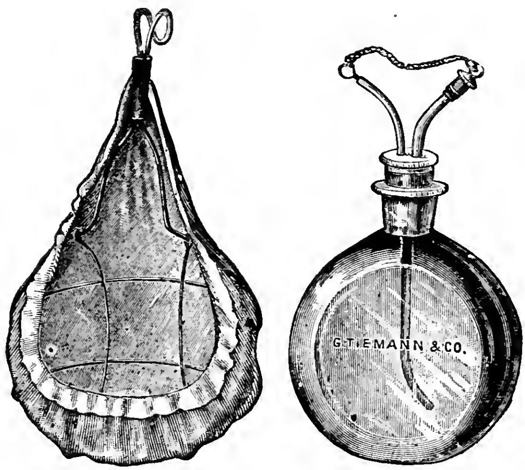


FIG. 10.—Esmarch's inhaler and chloroform bottle. The inhaler consists of a wire frame covered with a piece of flannel or gauze.

Æthylis Chloridum.—ETHYL CHLORIDE [C_2H_5Cl].—This drug is prepared by the action of hydrochloric acid gas upon absolute alcohol. It is a very volatile, colorless liquid, having an agreeable odor and burning taste. It is very soluble in alcohol, but only slightly in water. Its most distinctive property is its low boiling-point (55° F.). Vaporizing rapidly at ordinary temperature, it is our most valuable and convenient refrigerant analgesic. The vapor is very inflammable, therefore it should not be used near a flame. As a general anesthetic, ethyl chloride has been in use for a number of years, both as preliminary to ether, and used alone to induce transient anesthesia. It ranks with nitrous oxide as to rapid and transient action, but it is not destined to become popular because of its dangers. While its relative safety among anesthetics has not yet been definitely fixed by accumulated statistics, experience thus far places it below ether. In this respect it must, for the present, be classed with chloroform.

* Supplement, British Medical Journal, 1903.

An early series of 12,436 cases of anesthesia with ethyl chloride gives only one death that was proved to have been due to the drug. That case had a history of alcoholic abuse and the autopsy revealed degeneration of heart and arteries.*

McCardie† in 2000 cases saw neither asphyxia nor syncope in any case. His estimate later gives one death in 3000 cases. He has collected records of 21 deaths, and states that at least 30 deaths are known to have occurred under ethyl chloride, while several others have occurred from the proprietary mixture called somnoform.

Of the 21 deaths recorded, only 3 were of children, and 8 occurred in dental cases.

In these cases the "closed method" of inhalation is believed to have been commonly employed. This may have contributed an element of danger; for it cannot be too strongly emphasized that, with so powerful agents as chloroform, ethyl chloride and ether, the limitation of air, by use of a closed inhaler or a bag which requires rebreathing of the vapor-laden air, adds a danger of auto-intoxication which cannot be ignored.

Experiences thus far lead the above author to regard ethyl chloride as a substitute for ether and chloroform rather than for nitrous oxide, though in children under eight it is usually to be preferred to nitrous oxide. It is to be used with caution in dental cases, and the recumbent posture is advised.

Its depressant action is more evident upon the respiration than upon the circulation. When inhaled pure, without access of air, it causes death by paralyzing respiration. In 1000 cases by Ware‡ he noted 6 cases of serious danger, all of which were due to interference with respiration and all recovered under the use of artificial respiration. The same writer, after much experience, adapts the rubber mouth-piece of the nitrous oxide inhaler to ethyl chloride (Fig. 8), as here described in his own words:§

"The mask is prepared for use by stretching two layers of small-

* Lotheisen. Münch. Med. Woch., November 18, 1900, p. 601.

† British Med. Jour., March 17, 1906. Here also are noted the following estimates of the danger ratio of ethyl chloride:

Lotheisen first estimated the deaths as 1 : 2500. A later (April, 1902) estimate by the same writer, gives only 1 : 17,000.

Seitz's estimate, at about the same time, is 1 : 16,000.

In comparison, the following estimates are given for ether and nitrous oxide: Ether deaths, 1 : 16,000; nitrous oxide deaths, 1 : 1,000,000.

‡ Journal of the American Medical Association, No. 8, 1902.

§ Medical News, August 3, 1901, p. 169.

meshed gauze over the end of the tube *b*, which is then held taut by being forced into the neck *c* of the funnel-shaped rubber mouth-piece *a*. The gauze can be renewed at will and the whole apparatus, because of its simplicity, easily rendered sterile, a feature devoutly to be wished for in the laughing-gas mask and other kindred devices. The tube *b* is the channel along which the stream of ethyl chloride is directed against the gauze *c*, intended, not merely to receive the ethyl chloride, but also by impact to break it into still finer particles. At this point the ethyl chloride, evaporating, expands and is held by the walls of the mouth-piece *a* and the sides of the tube *b*, which, therefore, act as a chamber to temporarily limit the vapors.

"The entrance and exit of air are through one orifice, so as to minimize the loss of ethyl chloride and merely utilize the quantity momen-

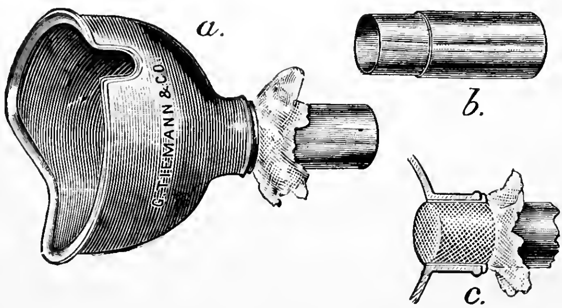


Fig. 11

tarily available for one or two respiratory acts. The stream is to be delivered intermittently from tubes provided with an automatic cut-off."

With ethyl chloride administered as described above, with proper admixture of air, anesthesia is induced in about the same time as nitrous oxide requires; the effects correspond very closely to those of the latter as to duration and recovery, but cyanosis is absent throughout.

For use in dental practice it may be said that, compared with nitrous oxide, ethyl chloride is more convenient and equally efficient, though less safe and requiring selection of cases and cautious use.

Somnoform, a proprietary mixture of ethyl chloride 60 parts, methyl chloride 35 parts, and ethyl bromide 5 parts, presents no advantage over pure ethyl chloride. Several deaths from its use have been reported.

Comparative Safety of Anesthetics.—The relative toxicity of these agents must depend largely upon their chemical make-up. If we compare the chemical formulæ of the four leading anesthetics, viz.:

Nitrous oxide	N_2O
Ether	$C_4H_{10}O$
Ethyl chloride	C_2H_5Cl
Chloroform	$CHCl_3$

we note differences that correspond to the increase in toxic power. Nitrous oxide is a very simple compound that has slight effect upon protoplasm. The hydrocarbon compounds have a more decided effect, that of ether being prolonged and profound without much danger from its action upon vital tissues; but with the introduction of a halogen element in combination with the organic radical, we find the harmful action to increase in proportion to the number of halogen atoms in the molecule. Thus, ethyl chloride contains a chlorine atom which makes it more toxic; while chloroform, with three atoms of chlorine is decidedly poisonous to tissues, frequently causing a positive degeneration.*

From these observations we are led to be skeptical as to the claims of safety for any new anesthetic containing a halogen element.

Briefly then, it may be stated for the agents now most employed, that nitrous oxide is the safest anesthetic in ordinary use; next in point of safety is ether, while chloroform and chloride of ethyl remain the least safe. The comparative safety of ether and chloroform, as given in a number of series of statistics, shows some variation, but it may be taken as a fair statement that ether is *five times* as safe as chloroform.†

A very interesting study of this question is that presented by the Committee of the British Medical Association appointed to investigate clinically the safety of the several anesthetics.‡ They studied 25,920 cases of general anesthesia, all occurring in the United Kingdom in the year 1892. Their conclusions include not simply deaths from anesthetics, but all cases of *danger* that could be attributed to the agent used. They found that dangerous symptoms occurred:

With *ether,* in 0.065 per cent. of cases.

With *nitrous oxide* and *ether,* in 0.096 per cent., and

With *chloroform,* in 0.582 per cent.

* The toxic effect may be due to halogen acids liberated from these compounds. See Am. Year Book of Anesthesia, 1915, p. 150.

† In connection with this, it is interesting to note the estimate of the comparative anesthetic power of ether and chloroform. It has been stated, as a result of experiments, that "the concentration of ether in serum necessary for complete anesthesia is 1 : 400; of chloroform, 1 : 4500 to 1 : 6000." Cited from Sollmann, American Medicine, September 10, 1904, p. 455.

‡ Lancet, London, 1901, vol. i, p. 280.

This would make the *danger ratio* about as follows:

Chloroform	9
Nitrous oxide and ether	1.5
Ether	1

It is conceded that *nitrous oxide alone* is least dangerous of all.

Mixtures of Anesthetics.—Besides the combined use of ether with nitrous oxide or ethyl chloride, mixtures of anesthetics cannot be very strongly advised. The old A. C. E. mixture of alcohol 1 part, chloroform 2 parts, and ether 3 parts is now seldom used. The differences in specific gravity and volatility of the several liquids, make it difficult to know what proportion of each the vapor contains. The Schleich mixtures for general anesthesia are not regarded, in general, with sufficient favor to constitute any recommendation of them. These must not be confused with the solutions for local analgesia, discussed on page 173. Schleich's idea in introducing mixtures of anesthetics for general anesthesia, was to obtain a liquid with a desired boiling-point (at about the temperature of the blood), to secure which he employed mixtures of ether, chloroform and petroleum ether with boiling-points varying between about 100° and 108° F. His belief in the relation between the action of an anesthetic and its boiling-point has not been accepted.

The mixture called somnoform (also advertised under the name of Brugg's Mixture) cannot be advised for the following reasons:

1. Being proprietary, its use is unethical.

2. It contains 5 per cent. of ethyl bromide [C_2H_5Br], which substance is regarded as less safe than ethyl chloride.*

3. With new agents, such as ethyl chloride, it is better to use the simple substance until its degree of safety has been determined, before resorting to any modification of it.

Resuscitation in Danger Cases.—With nitrous oxide, ethyl chloride, ether, and usually with chloroform, the danger is paralysis of respiration. When the condition is simply this, recovery may be expected, with proper treatment. But while the condition is a simple one with the three first-named agents, with chloroform there is always added a serious depression of the heart, and occasionally paraylsis of that organ. When the heart is paralyzed by chloroform its irritability is lost, which

* Sollmann (Pharmacology, 1906, p. 436) states that ethyl bromide "must not be pushed to the disappearance of reflexes, since the respiration is paralyzed about the same time. The zone of safety is, therefore, very narrow." The drug also deteriorates rapidly after exposure to air.

means death. But absence of the pulse beat must not be at once taken to mean paralysis, for, with the depressant action of the drug upon the heart, its pulsations may have become so feeble as to be imperceptible in the peripheral vessels; and it is not proper to waste time at first to ascertain the heart's condition. The *important thing immediately is arti-*

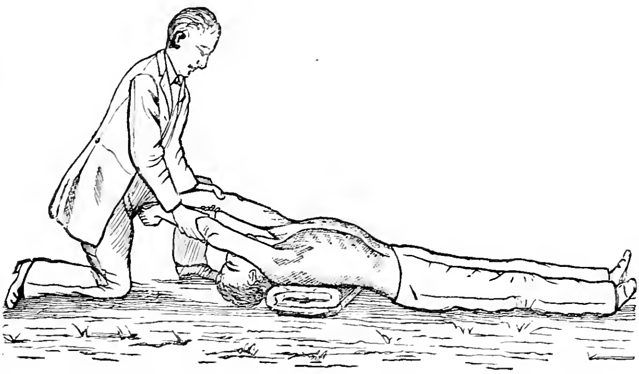


FIG. 12.—Sylvester's method of artificial respiration: movement of inspiration.

ficial respiration, which is itself here the best cardiac stimulant, and with its faithful continuance the real condition of the heart will soon appear; for artificial respiration not only supplies oxygen but facilitates the action of the heart, by relieving engorgement of its chambers, each expansion of the lungs favoring the emptying of the right ventricle and each contraction furnishing more blood to the left side of the heart for distri-

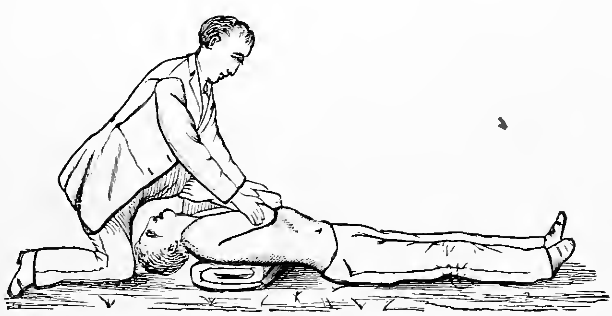


FIG. 13.—Sylvester's method of artificial respiration: movement of expiration.

bution. The *invariable treatment*, therefore, when respiration ceases, should be *artificial respiration* with free access of air, preceded, of course, by withdrawal of the anesthetic.

Artificial Respiration.—*Sylvester's method* of artificial respiration is the one most commonly employed. Figs. 12 and 13 show the position of patient and attendant. The movements of inspiration and expiration should succeed each other regularly at the rate of from twenty to twenty-five respirations per minute, or once in about three seconds.*

In imitation of natural respiration the inspiratory period should be slightly longer than the expiratory. In connection with this method, massage of the heart by an assistant, by pressure during expiration underneath the left ribs and upward toward the heart, so as to press the latter between diaphragm and chest wall, has come to be employed as an important aid in reëstablishing the heart's efficiency. It is most effectual in cases where the irrritability of the heart muscle is not much impaired.

The Schäfer or *Prone-pressure method* has gained favor in this country, as being at least as efficient as the Sylvester method and more easily performed by one person, since it requires less muscular exertion. It is carried on as follows: Have patient lying flat, with face downward and turned to side, tongue drawn forward and arms extended above head. Kneel aside, or preferably astride, the patient's thighs. For the *expiratory movement* place hands upon lower part of chest, thumbs nearly touching and fingers spread out over lower ribs; by a forward movement throw your weight, through your arms, upon patient's chest, thus compressing both chest and abdomen and effectually expelling air from lungs. For the *inspiratory movement* spring backward, relieving the pressure completely to allow chest to expand, but keeping hands in place. Time the movements to 15 to 20 complete respirations per minute, or by your own respiration—the forward expiratory movement with your expiration and the backward movement with your inspiration.

The *Howard method* of artificial respiration also is convenient and useful. It is described as follows:† "The patient is turned upon his back, and a bolster of clothing or of other material is placed under him so as to throw his epigastrium forward. His wrists are crossed behind his head and held in that position. His tongue is drawn forward and held with a dry handkerchief in the extreme corner of his mouth. The operator now kneels astride the patient's hips, 'resting the ball of each thumb upon the corresponding costoxiphoid ligaments, the fingers

* The average normal rate of respiration is about eighteen per minute, but as the need of aëration is urgent, and as artificial respiration is apt to be less efficient than the normal function, it is well to exceed the normal rate slightly.

† Atkinson. American Text-book of Applied Therapeutics, 1896, p. 37.

falling naturally into the lower intercostal spaces. Resting his elbow against his sides and using his knees as a pivot, he throws his whole weight slowly and steadily forward until his mouth nearly touches the mouth of the patient, and while he might slowly count *one, two, three;* then *suddenly,* by a final push, springs himself back into his first erect position on his knees; he remains there while he might slowly count *one, two,* then repeats, and so on about eight or ten times in a minute."

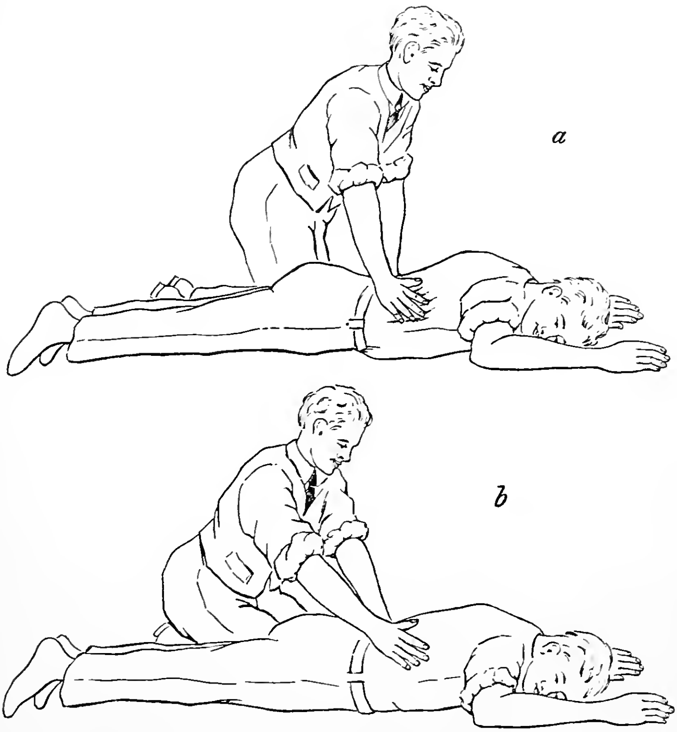


FIG. 14.—Schafer's prone-pressure method of artificial respiration. *a*, pressure being applied; *b*, pressure removed.

The *Laborde method* of rhythmic traction upon the tongue may be used as a stimulant to respiratory movements when there is any possibility of response, the tongue being grasped by the fingers over a dry napkin, or by a tenaculum or forceps, and drawn forcibly forward at intervals of about four seconds. Laborde holds that this measure excites reflexly the movements of the diaphragm especially.

A still more powerful means of exciting respiration reflexly, is that of rhythmically stretching the sphincter ani. This has been found very

useful in resuscitation from dangerous anesthesia and from opium poisoning.

MEDICINAL TREATMENT.—While artificial respiration must be kept up until natural respiration is restored, or until the hopelessness of the case has been absolutely established, an assistant must keep note of pulse and give respiratory and cardiac stimulants hypodermically, as required. The same medicinal treatment will be indicated here as in poisoning by cocaine, being careful to avoid vasodilators, especially where the arterial pressure is greatly reduced. (See Plate IV, p. 177.)

Strychnine, atropine, caffeine and digitalis, therefore, will be the drugs indicated, the last named being less needed in cases of simple asphyxia. Meanwhile, the so-called diffusible stimulants, such as ammonia by inhalation, or aromatic spirit of ammonia by the mouth ($\frac{1}{2}$–1 teaspoonful (2–4 mils) if swallowing is possible, may be given. [The suprarenal preparations (adrenalin, etc.), would usually be classed with these arterial stimulants; but in case of danger from chloroform they would be *absolutely contra-indicated,* because of their peculiar and dangerous effect upon the heart under chloroform. (See p. 207, note.)]

Alcohol.—ETHYLIC ALCOHOL.—*Spiritus Vini Rectificatus* [C_2H_6O.] (For preparations and doses, see Index of Drugs.) In alcohol we have an anesthetic agent that is practically not used as such. It has been commonly regarded as a stimulant, but a study of its full action, compared with that of ether and chloroform, must convince one of a real similarity, approaching an identity, in their effects. Whatever of stimulant effect it induces seems to be secondary to its local irritant action; in this respect it resembles ether. Its full anesthetic effect is so slowly produced and persists so long and is attended with such unpleasant symptoms (those of drunkenness), that it cannot ordinarily be used as an anesthetic. That it is a poison cannot be questioned. That it is capable of acting as a food is in accordance with the teaching of most authorities, but it cannot be regarded as an economical food in health.

Its precise action after absorption into the blood is not fully understood, except that in large doses it is anesthetic and poisonous. This latter fact should form the basis of a positive rule that alcohol should not be given in dangerous narcosis from ether or chloroform. It can only be admissible as a reflex stimulant, or as present in the aromatic spirit of ammonia or in other irritating diffusible stimulants. (The diagrams of Plate VIII are intended to show the present status of knowledge concerning the internal influence of alcohol.)

ALCOHOL.

Used commonly in the form of Whisky, Brandy, or Wine.

Classified as:

Irritant.	Stimulant.
Astringent.	Narcotic.
Antiseptic.	Anesthetic.

Physiologic action:

To summarize the physiologic effects of alcohol is very difficult, owing to the contradictory opinions held by good authorities. While most writers agree that the full effect of a large dose of the drug is that of a general depressant, there is no agreement as to the influence of a small dose.

Two diagrams are here presented:

Diagram A represents the action of a small dose as taught by those who hold that its primary influence includes stimulation of the cerebrum and of the heart.

Diagram B shows the depressant action of a large dose upon the nervous system, circulation, and digestion. Many observers deny the primary stimulant action, holding that the drug is a depressant from the first, or even in small dose. The excitement of intoxication is not due to stimulation, but to depression of the higher controlling centers.

Local action. Irritant, by reason of its affinity for water. When applied to the mucous membrane of the digestive tract, the irritation probably induces reflex stimulation, which may account in part for the primary stimulant effect attributed to the drug.

Digestion. In small doses, well diluted, alcohol seems to increase gastric secretion and motility, while stronger solutions (5 per cent. or more) retard the digestive process.

As a food the position of alcohol has not been very definitely determined. A small part only can be recovered as alcohol from the fluids of excretion. The greater part therefore is changed into other products, and is believed thereby to contribute some energy to the body. The economy to the system of its use may be open to question.

Metabolism. Its influence upon nutritive changes and upon elimination is uncertain.

PLATE VIII—A.

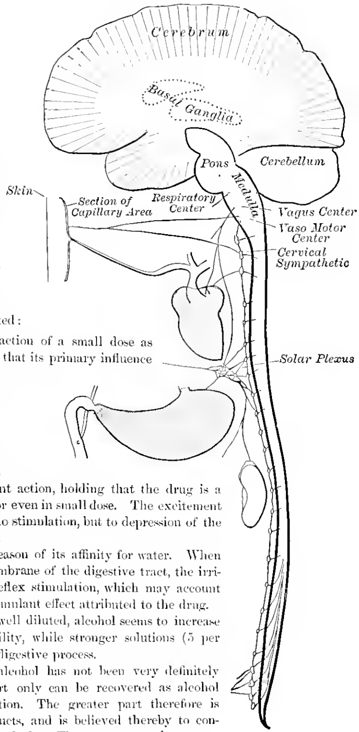
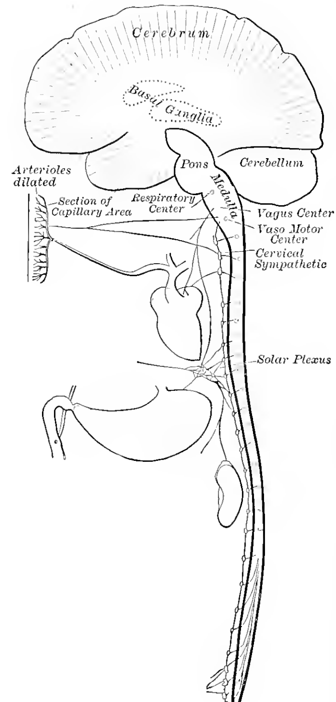


PLATE VIII.—B.



CHAPTER XV.

STIMULANTS AND TONICS.

STIMULANTS.

A STIMULANT is usually defined to be *an agent that increases the activity of an organic function or process.* But in the application of the principle of stimulation, a qualification of this definition should be noticed. We seek not simply to secure *rapidity,* but always *efficiency* of a function. Thus, in the majority of cases that call for a heart stimulant the heart's action is already rapid, and our most powerful stimulants, such as digitalis, in their full action actually slow the pulsations of the heart; but in spite of this the efficiency of the contraction is increased by them and the pulse improved in character. Again, the efficiency of a function may be lessened by undue inhibitory restraint. Here a stimulant result would require that the inhibitory influence be weakened. Belladonna acts in such manner, allowing the heart to beat more rapidly by *depressing* the inhibitory vagus nerve endings.

Having in mind, therefore, the real object of stimulation, *i. e.,* to *secure efficiency of a function,* we may employ agents that act in various ways, but always toward the same object.

Direct stimulants have their action directly upon the organ or tissue sought to be influenced. Their action may be to increase nervous, muscular or secretory activity. Such an agent might be called a **kinetic stimulant,** in that it changes latent into active energy. This increase of activity is at the expense of the reserve energy of the organ, and tends toward its exhaustion. This is an important consideration in the choice of a stimulant, and, indeed, in the decision whether *any* stimulant shall be employed, for the rapid exhaustion of the reserve power of an organ may defeat the object of our stimulation.

There are some stimulants, however, to which this objection scarcely applies—those that simply increase the irritability of nerve or muscle without calling forth any increase of activity, except in response to normal stimuli. These might be called **potential stimulants,** in that they increase the possibility of activity in response to normal stimuli. They do not tend particularly toward exhaustion of an organ. Strychnine is

a stimulant of this kind, its action being to increase the irritability of nerve centers.

Indirect stimulants produce the stimulant result secondarily. Some of these act primarily by *removing inhibitory influence* and others by causing an *irritation of sensory nerves.* An example of the former is the belladonna action, noted above, which primarily lessens the inhibitory influence of the vagus upon the heart, and thereby allows the heart to beat more rapidly, which is the *secondary or indirect* stimulant effect. Examples of the latter are ammonia, alcohol and ether, which are locally irritating to mucous membranes. By *irritating sensory nerve endings,* they induce a reflex or indirect stimulant effect.

Some stimulants are poisonous when given in excessive dosage; and the symptoms of toxic disturbances usually include delirium or convulsions.

(Because of the sensitiveness of the system in childhood, children do not bear stimulants as well as sedatives. They need stimulation less often than do older persons, and the response to stimulants is usually prompt.)

The Indication for Employing Stimulants is, in general, any depression of a function to a degree that may be regarded as *below the physiologic minimum* of its activity. We recognize that every organ has a certain range of action that may be called physiologic, within which it reacts to the work demanded of it, by increasing or lessening its activity. Functional activity, therefore, is a variable quantity, based upon the strength and nutritive resources of an organ, which are opposed by the amount of work imposed upon it. The physiologic minimum of activity, therefore, must vary as modified by these factors; but it may be defined to be the minimum of efficiency of a function under existing conditions. Now as long as an organ is working efficiently within its physiologic range it needs no stimulation. But when, either from its own inability or from excessive demands made upon it, its activity falls below its physiologic minimum, then stimulation may be employed to compel an extra expenditure of energy in enforced activity.

It is observed, moreover, that normally acting organs do not show much response to stimulants, but that those whose action is deficient respond well. When an organ is doing all the work that is required of it, it is difficult to force its action; but when the *need of doing more work* is present and a stimulant is applied, there appears to be a coöperation of factors, the *increased irritability* or the *more powerful impression* contributed by the applied stimulant enabling the organ to respond to the *need* of increased work, which, after all, is its normal stimulus.

Thus defined and limited, stimulants form a very important and indispensable class of remedies—the *kinetic* stimulants to serve as emergency remedies to tide an organ over a critical period, and the *potential* class to forestall failure of its function. Closely related to the latter are the agents usually classed as tonics, which may supply elements to the tissues or conserve the expenditure of energy by the cells.

Irritant Stimulants.

The indirect stimulants that produce a prompt circulatory effect have been termed *diffusible stimulants.* They are diffusible in effect rather than in action. Their action is mostly a reflex one, following local irritation of the sensory nerves in the mucous membrane. Their effects are usually transient.

Alcohol (ethylic).—The local action of this drug is fully considered in the chapter on Astringents; but the *secondary effects* arising from the marked irritation that attends its abstraction of water from the tissues and its coagulation of albumin, are those that may be called stimulant. They are reflex in nature, and are similar to the reflex effects following irritation of any sensory nerve. Alcohol should be used in a strength of not less than 50 per cent., in order to obtain the stimulant effect, which at best is slight and transient. It may be used either diluted or in the form of whisky or brandy. Pharmacologic experiments upon dogs do not prove alcohol to be a stimulant after its entrance into the circulation; there may be a slight temporary increase of pulse-rate, but arterial pressure is not raised.

On the whole, alcohol must rank as a rather feeble reflex stimulant, whose effect is uncertain and brief, and requiring, for continued effect, repeated doses that may later cause depression. For a single, prompt stimulant result, as in case of faintness, it is often useful.

It should be remarked that what is popularly regarded as stimulation by alcohol, *i. e.*, the hilarity, activity and talkativeness, are not stimulant effects at all, but rather the opposite. They correspond to the period of disturbed or imperfect consciousness common to anesthetics, and must be regarded as uncontrolled activity of the lower emotional and reflex centers, which occurs because the controlling function of the cerebrum has been depressed.

In large doses alcohol soon produces its characteristic depression of the whole central nervous system, while its continued use leads to degenerative changes in the arterial system, kidneys, liver and other highly vascular organs.

Æther.—ETHER.—This drug is fully considered in the chapter on Anesthetics. Its stimulant secondary effects, following primary irritation, are similar to those of alcohol. It is used in the following preparations:

Spiritus Ætheris.—SPIRIT OF ETHER.—(contains 325 parts of ether and 675 parts of alcohol.) Average dose f℥ 1 (4 mils).

Spiritus Ætheris Compositus.—COMPOUND SPIRIT OF ETHER.—*Hoffman's Anodyne* (contains 325 parts of ether, 650 parts of alcohol and 25 parts of ethereal oil. Not official.) Dose f℥ 1 (4 mils).

These preparations are given mostly by the stomach. Hypodermically they are quite irritating, although this should not prevent their use in emergency, if swallowing is difficult or impossible. Indeed, the greater irritation would likely induce greater reflex stimulation.

Ammonia [NH_3].—(For all preparations see Index of Drugs.) This substance has a decidedly irritant local action, and has the advantage of being a gas, which permits of inhalation. It is so volatile that it is always employed in solution, even for inhalation. In fact, the *aqua ammoniæ fortior* liberates the gas so rapidly as to be *caustic* in action, and is therefore *not to be employed* in any way as a stimulant, unless first diluted. The following preparations are commonly employed:

Aqua Ammoniæ.—WATER OF AMMONIA.—(contains 10 per cent. by weight of the gas in water.) Average dose ♏ 15 (1 mil) diluted.

Spiritus Ammoniæ Aromaticus.—AROMATIC SPIRIT OF AMMONIA.*—Average dose ♏ 30 (2 mils).

The aromatic spirit of ammonia is the best one of this class of stimulants for stomach administration. Its stimulant action is of longer duration because of the gradual decomposition of the ammonium carbonate, which thus liberates ammonia gas for some time. All ammonia preparations deteriorate with keeping unless kept tightly corked. Of the salts of ammonium the carbonate is a valuable stimulant.

Miscellaneous Stimulants.

Various other volatile substances have a more or less direct stimulant action, the reflex factor being much less because they are less irritating. The *volatile oils* and substances related to them belong to this class. A few only among them are important enough to be employed.

* Aromatic spirit of ammonia contains: Water of ammonia, 9 per cent.; carbonate of ammonium, 3.4 per cent., and small quantities of oils of lemon, lavender and nutmeg, with alcohol, 70 per cent.

These are stimulating to the central nervous system and to the heart. In large doses they may depress. Locally some are irritating, while others are sedative. They are much used internally as *carminatives, i. e.,* agents that relieve colic and cause expulsion of gas by relieving spasmodic contraction of the intestines.

Camphora.—CAMPHOR [$C_{10}H_{16}O$].—Average dose gr. 3 (0.2 gm.). A ketone derived from *Cinnamomun camphora.* It occurs in white, translucent, crystalline masses, which are soluble in alcohol, ether, chloroform, and oils, but almost insoluble in water. It has a strong odor and sharp aromatic taste. It is tough, but may be powdered in the presence of a little alcohol. (For preparations and doses, see Index of Drugs.)

Locally, camphor preparations are sedative except for the alcohol present as the solvent. Internally, it is a general stimulant to the nervous system and heart, but in large doses it may depress the brain, so as to cause delirium or convulsions. The spirit may be inhaled in syncope or faintness.

For internal use as a stimulant, camphor has acquired a place of first importance in the treatment of circulatory depression. It is given hypodermically, dissolved in a sterile fixed oil.

For *local application* certain combinations which modify the action of camphor are sometimes used. The basis for these is the fact that when camphor is triturated with either phenol, chloral hydrate, menthol or thymol, the mixture becomes liquid and is suitable for external use. Of these, *Camphorated phenol* (Camphophénique) and *Camphorated chloral* are most frequently employed.

Spiritus Camphoræ.—SPIRIT OF CAMPHOR.—Contains 10 per cent. of camphor in alcohol. Average dose, ♏ 15 (1 mil).

Oleum Menthæ Piperitæ.—OIL OF PEPPERMINT.—Average dose, ♏ 3 (0.2 mil). This is used mostly as a carminative, either in form of the spirit, or combined with cathartics to prevent griping. The local effect is sedative.

Heat.—The stimulant effect of heat is made use of in various ways. In case of shock or collapse a hot-water bag placed directly over the heart, or heat applied to the extremities, will be found useful. Copious injections of very warm water, or preferably warm normal salt solution, into the rectum and colon, is a very excellent means of stimulation by heat. The restorative value of the salt is also here apparent.

Liquir Sodii Chloridi Physiologicus.—NORMAL SALT SOLUTION.—This contains 0.85 per cent. of sodium chloride in sterile water. Its use by

hypodermoclysis, or intravenously, should be regarded today as one of the most important means of stimulation. It is rather *restoration*, by a fluid corresponding closely in salinity to the blood serum, which may be deficient or improperly distributed. Loss of blood by hemorrhage or loss of serum by a serous diarrhea, would especially indicate the use of saline solution. It is also useful in any condition of extreme depression. In severe cases of typhoid fever and other exhausting diseases, the patient is oftentimes tided over a critical period which might otherwise be fatal, by the daily use of one to four pints of normal salt solution hypodermically. The solution is prepared quite hot and allowed to run slowly through a large-sized, long hypodermic needle from a fountain syringe into the lumbar region or underneath the breast. Other stimulants may be added to the solution.

Belladonna—Atropina [$C_{17}H_{23}NO_3$]. (Plate IX.)

Belladonnæ Folia. Belladonnæ Radix.—This drug holds a unique place as being a central stimulant and peripheral depressant to the nervous system. Either the alkaloid atropine or the tincture of belladonna may be used as a respiratory and cardiac stimulant, atropine being always preferred for hypodermic use. But this drug must be regarded as a second-rate stimulant, and care must be taken not to exceed the physiologic limit, as it may then be disturbing or narcotic in effect. Locally applied, belladonna is anodyne, acting by depressing sensory nerve endings. It is used to allay local pain or irritation, as in neuralgia, for which purpose the plaster, ointment, or liniment of belladonna, or the oleate of atropine may be applied. (For preparations and doses, see Index of Drugs.)

Atropine in aqueous solution is dropped into the eye to dilate the pupil and to paralyze accommodation. Any preparation of belladonna or atropine promptly checks the excessive flow of saliva in mercurialism, for the treatment of which symptom it is our best agent. Sweating is also diminished by this drug, as are also various other secretions of the body. In checking secretion the drug acts by paralyzing the secretory nerve terminals within the glands.

The official salt of the alkaloid is **Atropinæ sulphas.**—Average dose gr. $\frac{1}{120}$ (0.0005 gm.).

The following alkaloids have an action somewhat similar to that of atropine:

BELLADONNA.

Leaves and root of Atropa B. The alkaloid Atropine represents the drug fully.

Classified as:

Cerebral stimulant.	Deliriant narcotic.	Mydriatic.
Cardiac stimulant.	Anodyne.	Antihidrotic.

Physiologic action:

In general, "atropine acts as a stimulant to the central nervous system and paralyzes the terminations of a number of the nerves, more especially of those that supply involuntary muscle, secretory glands and the heart." [CUSHNY.] It paralyzes peripheral inhibition. It decreases the secretions generally, except the urine, and increases the body temperature, producing a condition simulating fever.

Nervous System.

Brain. Stimulates the cerebrum, especially in its motor areas.

Medulla. Stimulates respiratory center.

Spinal cord. Depresses inhibitory centers.

Nerves.

Sensory. Depresses sensory nerve endings.

Motor. Depresses motor nerves.

Secretory. Paralyzes the endings of many of the secretory nerves, causing a diminution or arrest of the secretion; hence there result dryness of the mouth, lessened secretion of gastric and pancreatic juices and of milk. The sweat glands are rendered less active.

Vagus. Paralyzes the inhibitory terminations of the vagus within the heart, and the secretory terminations within the digestive system.

Muscular System. Depresses unstriped muscle, but has no influence upon voluntary muscle. Lessens the movements of stomach, intestines, bladder, uterus, and in general the organs containing unstriped muscle, except the arterial walls. [CUSHNY.]

Eye. Pupils are dilated by paralysis of terminals of the motor oculi nerve in the iris, whereby it paralyzes accommodation also. Most authorities state that it increases intraocular pressure.

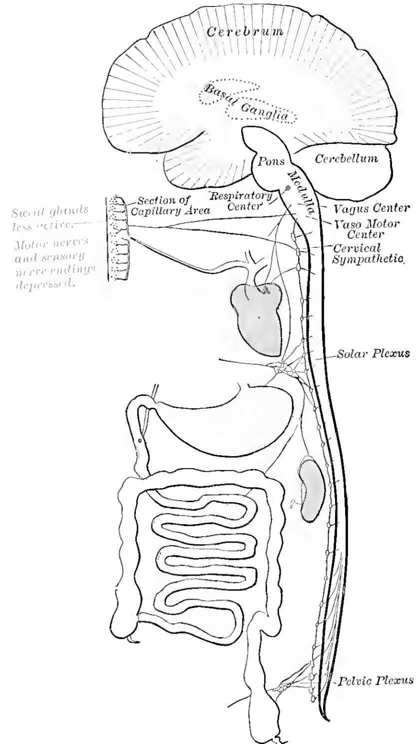
Circulation. Arterial pressure is increased, chiefly by its action upon the heart.

Heart. Increases pulse rate by paralyzing inhibition (peripheral ends of vagus). The heart muscle or its accelerator nerves may feebly be stimulated.

Respiration. Stimulated by action upon respiratory center.

Excretion. Perspiration is lessened. The drug is excreted rapidly by the kidneys, but its influence upon their activity is uncertain.

PLATE IX



The red color indicates stimulation, and the blue color depression.

PLATE X

CAFFEINE

An alkaloid existing in coffee, tea, guarana, and cola nut.

Classified as :

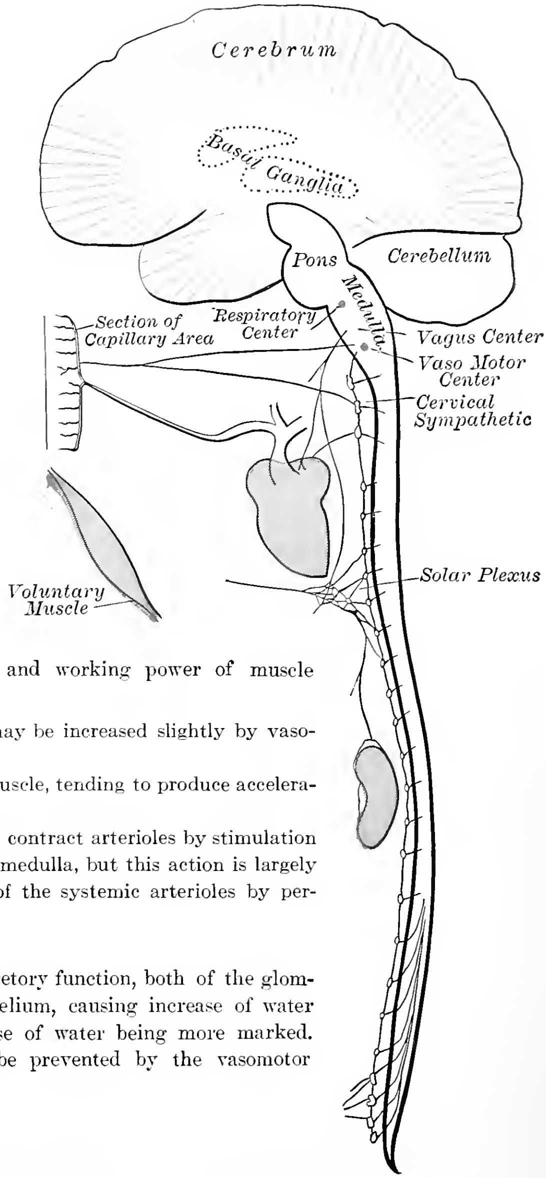
Cerebral stimulant.
Cardiac stimulant.
Respiratory stimulant.
Diuretic.

Physiologic action :

Nervous System.

Cerebrum. Stimulates cortex, increasing the activity of psychic functions.

Medulla. Stimulates respiratory center and vasomotor center. Vagus center may be stimulated, but the effect masked by the direct effect upon the heart.



Muscular System. Irritability and working power of muscle tissue increased.

Circulation. Arterial pressure may be increased slightly by vasomotor activity.

Heart. Stimulates heart muscle, tending to produce acceleration of the pulse.

Capillary area. Tends to contract arterioles by stimulation of vasomotor center in the medulla, but this action is largely neutrallized by dilatation of the systemic arterioles by peripheral action.

Excretion.

Kidneys. Stimulates excretory function, both of the glomeruli and the renal epithelium, causing increase of water and of solids, the increase of water being more marked. The diuretic effect may be prevented by the vasomotor action.

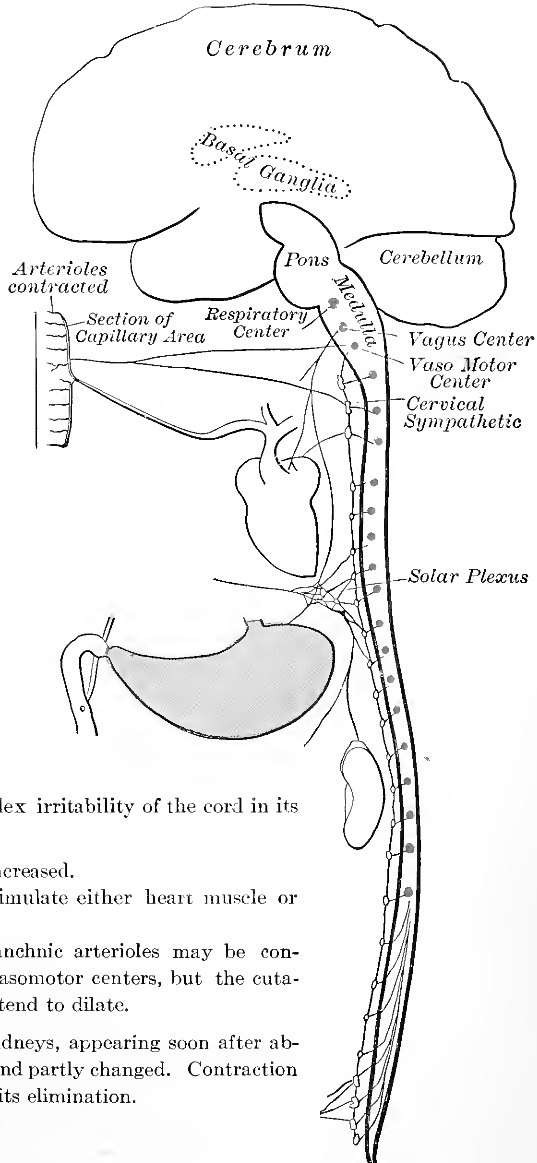
The red color indicates stimulation by Caffeine.

PLATE XI.

NUX VOMICA.

The seeds of Strychnos Nux V.

The alkaloid Strychnine represents the drug fully.



Classified as:

Bitter tonic.
Cardiac stimulant.
Nerve stimulant.
Excitomotor.

Physiologic action:

Digestive Tract. Stimulates secretion of gastric juice and motility of stomach and intestines.

Nervous System.

Cerebrum. No effect upon cortex. Consciousness not influenced. Special senses rendered more acute.

Medulla. Stimulates respiratory and vasomotor centers. Vagus center may be slightly stimulated.

Spinal cord. Increases reflex irritability of the cord in its whole extent.

Circulation. Arterial pressure increased.

Heart. It is believed to stimulate either heart muscle or cardiac ganglia, or both.

Capillary area. The splanchnic arterioles may be contracted by its action upon vasomotor centers, but the cutaneous and muscular vessels tend to dilate.

Excretion. Eliminated by the kidneys, appearing soon after absorption, partly unchanged and partly changed. Contraction of renal vessels may hinder its elimination.

The red color indicates the stimulant action of Nux Vomica or Strychnine.

Homatropinæ Hydrobromidum, an artificial alkaloid, is used as a mydriatic, producing a more rapid and more transient dilatation of the pupil than does atropine. It is used locally. (See Index of Drugs.)

Hyoscyaminæ Hydrobromidum, average dose gr. $\frac{1}{200}$ (0.0003 gr.). Obtained from Hyoscyamus and other *Solanaceæ.* Used as sedative.

Scopolaminæ Hydrobromidum (Hyoscinæ Hydrobromidum), average dose gr. $\frac{1}{200}$ (0.0003 gm.). Obtained from *Hyoscyamus* leaves, *Scopola* root and other *Solanaceæ.* This is less stimulating than atropine; in fact, is used only as hypnotic and sedative. (See Index of Drugs.)

Caffeina. CAFFEINE [$C_8H_{10}N_4O_2+H_2O$]. (Plate X.)

Caffeina Citrata.—CITRATED CAFFEINE.—Average dose, gr. 5 (0.30 gm.). This alkaloid, obtained from tea and coffee, has an important use as a heart and cerebral stimulant and as a diuretic. It is entirely safe to be used in large doses, therefore it is one of the best stimulants to employ in poisoning by narcotics. The citrated caffeine is the preparation usually employed, because more soluble than caffeine. (See note on p. 177.)

Caffeinæ Sodio-Benzoas.—CAFFEINE SODIO-BENZOATE.—Average dose by mouth, gr. 5 (0.30 gm.). hypodermic, gr. 3 (0.20 gm.). This is the best salt of caffeine for hypodermic use, because of its free solubility in water, being soluble in 1.1 parts.

Theobromine (from *Theobroma cacao* and from *Guarana*) has an action upon the circulation similar to that of caffeine, but is superior as a diuretic, and less stimulating to the cerebrum. (Not official.)

Nux Vomica—Strychnina [$C_{21}H_{22}N_2O_2$]. (Plate XI.)

(For preparations and doses, see Index of Drugs.)

This drug easily ranks as one of the very best general stimulants. In large doses it is poisonous, but it is not narcotic, therefore it can be pushed to its physiologic limit with less danger than is the case with belladonna. It increases the irritability of nerve centers to normal stimuli, and does not tend directly to exhaustion. It is a valuable respiratory stimulant by action upon the centers.

In all conditions of general depression, cardiac weakness, in infectious diseases, pneumonia, typhoid fever, in poisoning by cocaine, opium and other narcotics, it is useful. It is also used as a bitter, stomachic tonic.

Internally any preparation may be given. Hypodermically a salt of the alkaloid strychnine is employed. The official salts of strychnine are:

Strychninæ Nitras.—Average dose, gr. $\frac{1}{40}$ (0.0015 gm.).

Strychninæ Sulphas.—Average dose, gr. $\frac{1}{40}$ (0.0015 gm.).

(For symptoms and treatment of poisoning by strychnine, see Table of Poisons and Antidotes.)

Digitalis. (Plate XII.)

(For preparations and doses, see Index of Drugs.)

Digitalis is used whenever the heart is unequal to its task, by reason of dilatation or simple weakness. When extensive fatty degeneration is present, and in certain valvular defects, it is not the drug of choice, but may be required. As it "whips up" the heart to greater exertion, its use should be discontinued as soon as possible, so as to avoid exhaustion of the organ. It should be regarded as an *emergency* drug in cardiac diseases. It is a great mistake to suppose that digitalis is needed in every case of valvular disease; for when any cardiac disease is fully compensated, and in simple hypertrophy, digitalis should not be used. When arterial pressure is high the drug is not indicated. In these conditions the drug may do harm. The tincture and the infusion are the preparations mostly employed. In emergency the tincture may be used hypodermically in full dose. The drug acts slowly, and it therefore cannot be relied upon alone as an emergency stimulant.

Strophanthus, a drug that acts similarly to digitalis, is used as a substitute for it.

(For preparations and doses, see Index of Drugs.)

Nitrites. (Plate XIII.)

The nitrites are indicated in conditions of high arterial pressure, due to disease of the arteries or constriction of arterioles. They cannot be regarded as direct heart stimulants of any decided power, but they act in an equivalent way, by reducing the work of the heart through dilating the arterioles. In this way the resistance against which the heart has to force the blood is largely removed, and at the same time its action is accelerated, so that a freer capillary supply results. Nitrites should not be used in conditions of low arterial pressure. NITROGLYCERIN in tablet form, or its 1 per cent. solution (*Spiritus Glycerylis Nitratis*) is

PLATE XII.

DIGITALIS.

The leaves of D. Purpurea.

NOTE.—The description below is of the action of the drug or of preparations fully representing it.

Classified as:

Cardiac stimulant.
Cardiac tonic.
Diuretic.

Physiologic action :

Stomach. Absorbed slowly. Irritant in large doses or when long continued.

Nervous System.

Brain. No influence upon the cerebrum.

Medulla. Stimulates vagus centers.

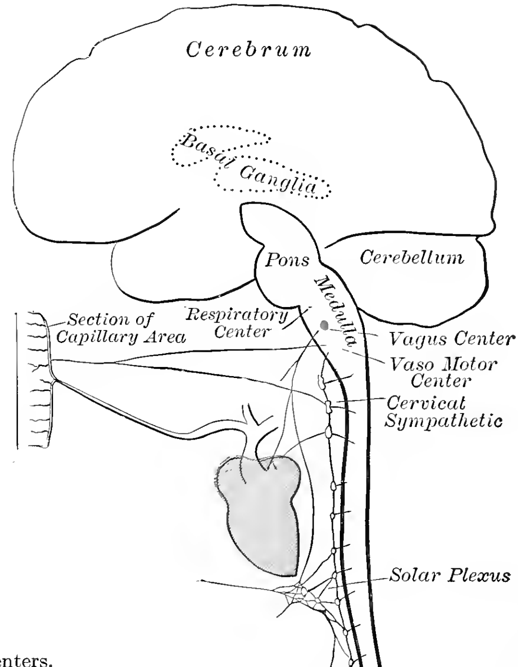
Circulation. Gives greater force and rapidity to arterial current.

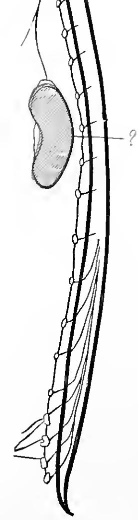
Heart. Stimulates the inhibitory influence (vagus, center), which slows the heart and tends toward relaxation. Stimulates the cardiac muscle and contained ganglia, giving greater force to the contractions.

Capillary area. No direct action in therapeutic doses. With improved circulation in the brain, from the heart stimulant effect, relaxation of arterioles occurs which prevents any great increase of blood pressure.

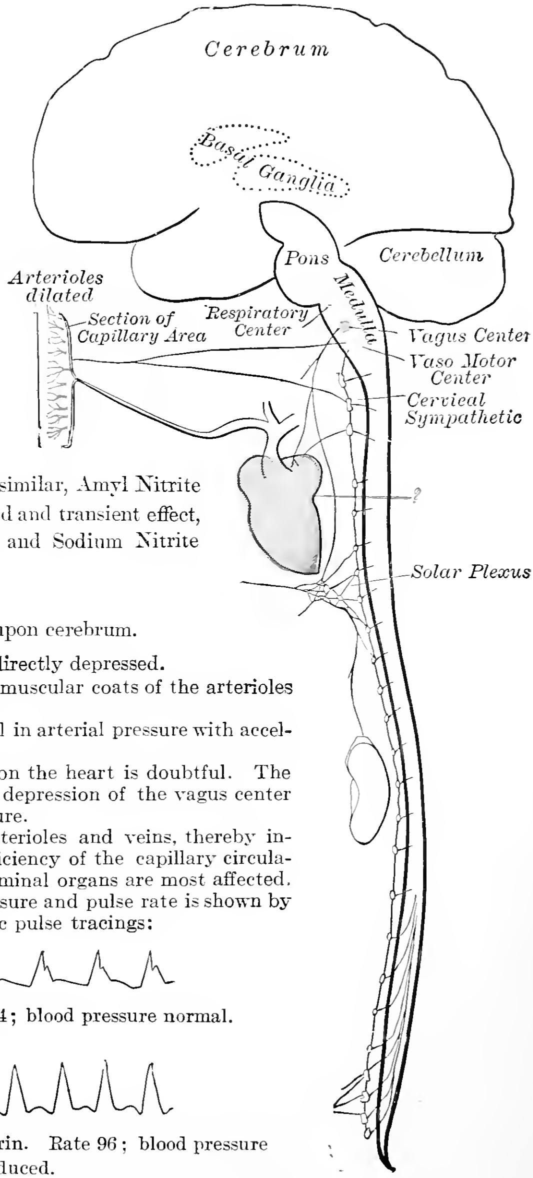
Excretion.

Kidneys. Direct action upon the renal epithelium is uncertain. The urine is increased, but mainly through the influence of an improved circulation.





The red color indicates the stimulant action of Digitalis.



NITRITES.

AMYL NITRITE,
♏ 1–5 (Gm. .06–.30).
NITROGLYCERIN (*Glonoin, Trinitrin*).
gr. $\frac{1}{120}$–$\frac{1}{60}$ (Gm. .0005–.001).
SPIRITUS GLYCERYLIS NITRATIS, 1 per cent. Nitroglycerin.
♏ $\frac{1}{2}$–2 (Gm. .03–.12).
SODIUM NITRITE,
gr. 1–3 (Gm. .06–.20).

Classified as:
Vasodilators.
Circulatory stimulants.

Physiologic action:

While the action of the several drugs of this group is very similar, Amyl Nitrite (by inhalation) has the most rapid and transient effect, Nitroglycerin is most powerful, and Sodium Nitrite has the most permanent effect.

Nervous System.

Brain. No direct influence upon cerebrum.

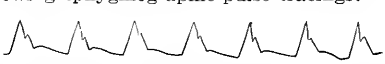
Medulla. Vagus center is indirectly depressed.

Muscular System. Paralyzes the muscular coats of the arterioles and veins by direct action.

Circulation. Causes a decided fall in arterial pressure with acceleration of the pulse.

Heart. Any direct action upon the heart is doubtful. The acceleration is due mainly to depression of the vagus center through lessened blood pressure.

Capillary area. Dilates arterioles and veins, thereby increasing the volume and efficiency of the capillary circulation; vessels of face and abdominal organs are most affected. The influence upon arterial pressure and pulse rate is shown by the following sphygmographic pulse tracings:



Normal pulse tracing. Rate 84; blood pressure normal.

The same after taking Nitroglycerin. Rate 96; blood pressure greatly reduced.

The red color indicates the stimulant effects of the nitrites; the blue color indicates their depressant action upon the vagus center, which is the chief cause of the increase in pulse rate.

NOTE.—The blood changes produced in animals by Amyl Nitrite are not seen in man following therapeutic dosage.

commonly employed. It is the best representative of the group of nitrites.

It is not necessary to give nitrites hypodermically, as the effect of AMYL NITRITE may be obtained almost instantly by inhalation, and a tablet of nitroglycerin placed under the tongue will produce its effect in from three to five minutes. Its action also completely disappears in from thirty to sixty minutes. When the drug is really indicated it may be given every hour for several doses if necessary, or the dose may be increased as needed.

SODIUM NITRITE is employed when a slower but more sustained effect is desired.

In conditions that are believed to be due to arterial spasm or constriction, as angina pectoris and asthma, the nitrites are useful for temporary relief; and in arteriosclerosis they sometimes constitute the principal medicinal treatment.

There is no doubt that the value of the nitrites was earlier overestimated. Upon the plain indications mentioned above they occupy a place of usefulness that is their own, no other drugs being comparable to them; but it was unfortunate that the belief became current that they were direct heart stimulants. For, with this belief as a basis, they were used in such diseases as pneumonia and other acute infectious diseases, when the blood pressure was already too low to allow efficiency of circulation, and in cases of chloroform narcosis, where the same condition prevailed. In fact, it was the practice of some, the more cardiac stimulation was needed, the more to resort to the nitrites; while it is true in the main that the more cardiac stimulation is needed the less are the nitrites indicated.

The nitrites should be viewed as vasodilators, not as heart stimulants. But in their action as vasodilators they may be regarded as *circulatory* stimulants. The capillary area fed by the arterioles is, after all, the most important part of the circulation, for it is there, in the cells of the tissues, that all nutritive changes occur and all functional activity is maintained. In conditions of *high arterial pressure,* the blood supply to the capillaries is often lessened by the tendency to constriction of the arterioles. The nitrites, by dilating the arterioles, will increase the blood supply to the capillary area and furnish better nutritive materials for cell activity—a true *circulatory* stimulation, but not heart stimulation.

It is worthy of note that, whatever the beneficial result, the physiologic action of the nitrites is chiefly depressant to the vasoconstrictor muscle tissue in the arterioles.

TONICS.

Tonics are frequently defined as permanent stimulants. This conveys the idea of permanency of result which always pertains to the class, but we must note that tonics may not have any proper stimulating action. It is difficult to form a definition that will include all remedies of the class, because of the wide difference in their nature and action. Their chief value is in relation to the reserve energy of organs, which they conserve by supplying the necessary materials for tissue renovation and for the production of energy, or by otherwise promoting nutrition. Iron is classed as a *restorative tonic* for the reason that it supplies a normal constituent to the blood and tissues. The ordinary foods hold a similar place and must be regarded as tonics in the sense that they restore needed material. On the other hand, bathing and massage will promote the general nutrition of the body, and are, therefore, tonic remedies. The simple bitters, such as gentian, taken into the stomach, stimulate the digestive functions and thus indirectly promote general nutrition.

A simple classification which will aid our study of these substances, may be made as follows:

Nutritional Tonics—those that promote the general processes of nutrition.

Examples.—Bitter tonics, bathing, and massage.

Restorative Tonics—those that supply material for tissue reconstruction or energy production.

Examples.—Iron, foods, and phosphorus.

Nutritional Tonics.

Among the class of nutritional tonics—*i. e.*, those that promote the general processes of nutrition—are those that act by increasing the activity of digestion. These are known as stomachic tonics or *simple bitters*. Their chief characteristic is their bitterness, by which they seem to stimulate, possibly through primary irritation, the mucous membrane and secretory glands of the stomach. The immediate result of their presence in the stomach is to retard or lessen secretion, but this is soon succeeded by an increase of secretion, so that the full effect, obtained fifteen to thirty minutes after administration, is an increase of gastric juice and of motility of the stomach. They should be given before meals so that their full action may be secured in time for the beginning of stomach digestion. The chief agents of this character are here given. (For preparations and doses, see Index of Drugs.)

Simple Bitters.

Calumba.—COLUMBO.—The root of *Jateorrhiza palmata.*

Gentiana.—GENTIAN.—The root of *Gentiana lutea.*

Quassia.—The wood of *Picrasma excelsa* or of *Quassia amara.*

Of any of these the tincture (in case of gentian the compound tincture) is a leading preparation and may be given, in case of each, in a dose of f℥ $\frac{1}{4}$–1 (1–4 mils). The infusion of quassia is easily prepared with cold water, and may be given freely.

To this group of simple bitters must be added several other drugs that are equally efficient as stomachics, but whose more important action gives them a larger place. They are sometimes called:

Peculiar Bitters.

Cinchona.—PERUVIAN BARK.—The bark of a number of species of cinchona. It contains quinine and many other alkaloids. (For preparations and doses, see Index of Drugs.) **Quinine** represents the drug fully. (For its combinations and doses, see Index of Drugs.)

Besides being a bitter tonic, quinine is an efficient antiseptic, but its bitterness prevents its extensive internal use as such; although it is sometimes employed as an intestinal antiseptic, given by stomach or injected into the colon. Its most valuable and distinctive use is in malarial fever (fever and ague), in which disease it is a specific, preventing in the blood the growth of the plasmodium malariæ, upon which the disease depends. This must be regarded as a true *antiseptic action,* obtained after absorption of the drug, which for this purpose is given in full dose of 15 to 30 grains (1–2 gm.) daily, in single or divided doses. A favorite method is to give 15 grains (1 gm.) in one dose daily, about three hours before the expected paroxysm. The average tonic dose of a quinine salt is gr. $1\frac{1}{2}$ (0.1 gm.), before each meal.

A form of supra-orbital neuralgia supposed to be of malarial origin, known as *brow ague,* which presents the periodic character of malarial fever, in that it occurs at about the same hour each day, or every second day, continues with severity for some hours and then disappears, is promptly relieved by a full dose of quinine daily, three hours before the usual time of its onset.

Quinine sulphate is the salt mostly employed, but it is only slightly soluble in water, except when an acid is added. The bisulphate is freely soluble. With the giving of large doses of quinine there occur the evidences of saturation, that are known as *cinchonism.* Ringing in the ears and fulness of the head are the symptoms of this condition, which is not serious, but passes away soon after cessation of the drug. Quinine

is used much less now than it was in former years, before its precise action and its limitations were understood.

Nux Vomica.—The seeds of *Strychnos Nux-vomica*, containing not less than 2.25 per cent. of alkaloids. (For preparations and doses, see Index of Drugs.) The chief alkaloid, **strychnine**, has been fully considered as a stimulant. It is valuable also as a bitter tonic, as are the preparations of nux vomica. All preparations are intensely and persistently bitter. The special value of this drug, in its general tonic use, lies in the fact that, after its local effect in the stomach, its absorption is followed by a general increase in the activity of all reflexes, through its action upon nerve centers of reflex action. This is the effect that pertains to the action of the alkaloid strychnine in its use as a stimulant. The tincture of nux vomica is the preparation most commonly used as a bitter tonic. In large doses the drug is poisonous, causing very characteristic tonic convulsions which affect chiefly the muscles whose nerve supply is directly from the spinal cord. (See Table of Poisons and Antidotes.)

Prunus Virginiana.—Wild Cherry.—The bark of *Prunus serotina*, gathered in the autumn. (For preparations and doses, see Index of Drugs.) In addition to its action as a stomachic tonic, this drug possesses decided sedative properties, which are due to the presence of *hydrocyanic acid* in its preparations. This substance does not exist in the crude drug, but is developed when the latter is treated with cold water. By a reaction between two constituents, *amygdalin* and *emulsin*, a volatile oil identical with oil of bitter almond is formed. This contains hydrocyanic acid. Wild cherry finds its special use where a general or local nerve sedative is indicated, in connection with a stomachic tonic. In cough mixtures its preparations fill a useful place. Its local sedative and tonic effects make it a remedy that is applicable in irritable conditions of the stomach, to control vomiting and improve digestion.

Restorative Tonics.

This class comprises both the ordinary food substances, that supply material for tissue reconstruction and energy production, and the medicinal agents that are really foods in the sense that they are necessary to the tissues.

Passing the ordinary food substances with the simple mention of oxygen, water, starchy, fatty and nitrogenous foods and sodium chloride, our chief consideration will be given to the restoratives ordinarily regarded as medicines. Inasmuch as they aid chiefly by restoring some *element that is lacking*, their precise action requires no extended dis-

cussion. We are more concerned with the form or combination of the drug in order to pleasant administration and ready assimilation.

Ferrum.—IRON [Fe].—(For preparations, their reactions and doses, see Index of Drugs.) This metal is commonly employed either in its pure form of reduced iron or in one of its many combinations. The large number of these supply every need of form, and of adaptability to the various conditions that call for its use. Those most frequently used are ferrum reductum, massa ferri carbonatis, ferri pyrophosphas, tinctura ferri chloridi, and syrupus ferri iodidi. The last-named is alterative as well as restorative, and a most useful agent in the treatment of so-called scrofulous conditions in children.

Besides these preparations the great variety of compound salts find special uses. *Ferri hydroxidum,* or *ferric hydrate,* is the most useful chemical antidote to arsenic. The real *systemic action of iron* is mainly in the blood, and, whatever salt or combination is employed, the iron is believed to be changed to the chloride before absorption. It furnishes material for the coloring matter of the red cells, therefore it is especially indicated where there is deficiency of hemoglobin (chlorosis).

It should be insisted upon that it is unnecessary to use the new and largely advertised preparations of iron. As a rule they are expensive, and they are not at all superior to the older, well-known, official forms. The reaction of iron salts should be noticed, and for prolonged use those that are neutral selected by preference, so as to avoid damage to the teeth. Only those that have an acid reaction can affect the tooth structure, but staining may follow the use of any preparation in a mouth that is not kept scrupulously clean. This stain, which is usually sulphide of iron, may be easily removed from the surface of the enamel, but in a cavity it may be more permanent. The tincture of the chloride is one of the strongly acid preparations that must be used with care. Its contact with the teeth may be limited by taking it through a glass tube, but a more positive safeguard is to ensure neutralization of the acid by rinsing the mouth, before and after taking, with a solution of sodium bicarbonate or other alkali.

Mineral Acids.—These are used internally only in the dilute form. Even then they should be further diluted, and the same precautions taken to protect the teeth as are mentioned above.

Acidum Hydrochloricum Dilutum.—DILUTED HYDROCHLORIC ACID.—10 per cent. by weight of absolute hydrochloric acid.

Acidum Nitricum Dilutum.—DILUTED NITRIC ACID.—10 per cent. by weight of absolute nitric acid (not official).

Acidum Nitrohydrochloricum Dilutum.—DILUTED NITROHYDROCHLORIC ACID.—4 per cent. nitric acid and 18.2 per cent. hydrochloric acid.

Acidum Sulphuricum Dilutum.—DILUTED SULPHURIC ACID.—10 per cent. by weight of absolute sulphuric acid.

Acidum Sulphuricum Aromaticum.—AROMATIC SULPHURIC ACID.—20 per cent. by weight (or about 10 per cent. by volume) of absolute sulphuric acid in nearly pure alcohol.

The average dose of either of these is ♏ 15 (1 mil). They are given after meals, as a rule. A very important use of dilute hydrochloric acid is to restore the quality of the gastric juice when its acid is deficient. It being the normal acid of this digestive fluid, its administration furnishes one of the most typical instances of restorative treatment.

Vegetable Acids.—These include:

Acidum Citricum.—CITRIC ACID.

Acidum Tartaricum.—TARTARIC ACID.

It is not easy to explain the action of vegetable acids upon the ground of supplying normal elements that are lacking in the system. But their use is established by long clinical experience in certain conditions of disturbed nutrition that follow prolonged abstinence from fresh foods, as with sailors upon long sea voyages. The disease induced is known as *scurvy,* and it seems to present an altered or depraved condition of the blood as its chief pathology. Upon the skin and mucous membranes more or less extensive spots of ecchymosis occur, the particular kind of lesion being known as purpura. The abnormal condition of blood is usually promptly removed, with full return of health, by a free supply of fresh fruits, vegetables, and meats. Citric acid, alone or as present in the juice of lemons or limes, is a valuable addition to the dietetic treatment of scurvy. Orange-juice is likewise added to the diet of infants fed upon sterilized or pasteurized milk. Tartaric acid is used simply as a substitute for citric acid.

Phosphorus [P].—(For preparations and doses, see Index of Drugs.) This substance is of the greatest importance to the system, in its capacity as a restorative. Among other effects of its prolonged use, it has been shown to have the power of inducing more rapid growth of bone, as was found to result in experiments upon animals.* Accordingly, it may be of service in delayed dentition and in rachitis; but, owing to the very disagreeable taste of pure phosphorus, we usually have to be content with the use of phosphates, hypophosphites and dilute phos-

* Therapeutics, H. C. Wood, eleventh edition, pp. 431–32.

phoric acid. The most common form of pure phosphorus for administration is the official pill containing $\frac{1}{100}$ of a grain (0.0006 gm.). It is particularly indicated in certain diseases of the nervous system and in conditions of deficient bone nutrition.

(For poisoning by phosphorus, see Table of Poisons and Antidotes.)

Acidum Phosphoricum Dilutum.—Diluted Phosphoric Acid.—10 per cent. This acid is used as a general nerve tonic and substitute for phosphorus. Average dose ♏ 30 (2 mils).

Syrupus Hypophosphitum.—Syrup of Hypophosphites.—(Incompatible with tincture of chloride of iron.) Average dose f℥ $2\frac{1}{2}$ (10 mils).

Syrupus Hypophosphitum Compositus.—Compound Syrup of Hypophosphites (not official). Average dose, f℥ 1 (4 mils).

Syrupus Ferri, Quininæ et Strychninæ Phosphatum.—Syrup of the Phosphates of Iron, Quinine and Strychnine (not official). Dose f℥ $\frac{1}{2}$–1 (2–4 mils).

The hypophosphites are useful, both as substitutes for phosphorus and as furnishing combinations of the drug that may be more easily appropriated by the system. They are certainly less unpleasant to take. They are largely used in rachitis, in wasting diseases such as tuberculosis, and in diseases of the blood and of the nervous system.

Oleum Morrhuæ.—Cod-liver Oil.—A fixed oil expressed from the fresh livers of *Gadus morrhua* and other species of *Gadus*. Average dose, f℥ $2\frac{1}{2}$ (10 mils).

It is produced mostly upon the coasts of Norway, Newfoundland and Massachusetts.

Its value is that of a fatty food which also contains traces of iodine, chlorine, bromine, phosphorus and sulphur. These contribute a slightly alterative property to the oil. It is used in wasting diseases, especially in tuberculosis, and in poorly nourished children. The so-called scrofulous conditions are benefited by it. The taste of the oil is disagreeable to many, so it is used largely in the form of emulsion. The pure oil is sometimes used by inunction when stomach administration is impracticable. If taken about two hours after meals much of the unpleasantness in the way of eructations will be avoided. Typical emulsions are the following:

Emulsum Olei Morrhuæ.—Emulsion of Cod-liver Oil.—50 per cent. Average dose, f℥ 4 (15 mils).

Emulsum Olei Morrhuæ cum Hypophosphitibus.—Emulsion of Cod-liver Oil with Hypophosphites.—This contains 50 per cent. oil, with hypophosphites of calcium, potassium and sodium (not official). Average dose, f℥ 4 (15 mils).

CHAPTER XVI.

ALTERATIVES.

Alteratives have been defined as agents that counteract morbid states of tissues by altering the processes of nutrition in a favorable manner. They seem to have little direct influence upon irritability or functional activity of cells. Alteratives become a part of the cell contents for the time that they remain in the system, and some of the metallic alteratives become so fixed that they may be detected for weeks in the tissues. Their action is slow and their effects permanent, as might be expected of agents that enter so intimately into the composition of the cells. The typical conditions that call for their use are those that are brought about by the damaging influence of bacteria or toxic chemical bodies, that alter the nutrition of the cells. Syphilis stands as the disease that probably most purely presents the indications for the use of alteratives. Altered states of the blood and of organs likewise call for their use.

The precise mode of action of alteratives is obscure, their effects appearing without any evident changes of organic functions, except that of gradual improvement.

Arseni Trioxidum.—Arsenic.—*Arsenous Acid* [As_2O_3].—The value of arsenic internally is mostly as a blood alterative, in those forms of anemia where the red cells are abnormal. It is also useful in certain nervous diseases, particularly in chorea (St. Vitus' dance), and in some chronic diseases of the skin.

Liquor Acidi Arsenosi.—Solution of Arsenous Acid.—1 per cent.

Liquor Potassii Arsenitis.—Fowler's Solution.—Strength corresponds to 1 per cent. of arsenic trioxide.

Liquor Sodii Arsenatis.—1 per cent.

These three solutions are uniform in strength and have the same average dose, ♏ 3 (0.2 mil). The first is *acid* in reaction, while the second and third are *alkaline*.

Liquor Arseni et Hydrargyri Iodidi.—Donovan's Solution.—1 per cent. each of arsenous iodide and mercuric iodide. Average dose, ♏ 1½ (0.1 mil).

The pure arsenic trioxide and Fowler's solution are the forms most

commonly employed. Beginning with small or moderate doses, they may be increased to the limit of toleration, which is shown by irritability of the stomach and puffiness about the eyelids.

Donovan's solution is a more powerful general alterative, as it combines arsenic, mercury and iodine.

Hydrargyrum.—MERCURY.—*Quicksilver* [Hg].—(For fuller list of preparations and doses, see Index of Drugs.) Mercury is used very largely in the form of combinations, but there are several preparations in which metallic mercury is used, reduced to a very finely divided condition. Following are the preparations most commonly used:

Hydrargyrum cum Creta.—MERCURY WITH CHALK.—Contains 38 per cent. by weight, of metallic mercury.

Massa Hydrargyri.—BLUE MASS.—*Blue Pill.*—Contains 33 per cent., by weight, of metallic mercury.

Unguentum Hydrargyri.—BLUE OINTMENT.—Contains 50 per cent., by weight, of metallic mercury.

Oleatum Hydrargyri.—OLEATE OF MERCURY.—Contains 25 per cent., by weight, of yellow mercuric oxide.

Hydrargyri Chloridum Mite.—MILD MERCUROUS CHLORIDE.—*Calomel. Monochloride of Mercury. Protochloride of Mercury* [HgCl].

Hydrargyri Chloridum Corrosivum.—CORROSIVE MERCURIC CHLORIDE.—*Corrosive Sublimate. Bichloride of Mercury. Perchloride of Mercury* [$HgCl_2$].

Hydrargyri Iodidum Flavum.—YELLOW MERCUROUS IODIDE.

Hydrargyri Iodidum Rubrum.—RED MERCURIC IODIDE.

Hydrargyri Salicylas.—MERCURIC SALICYLATE.—*Mercuric Sub-salicylate.*—This salt is used largely hypodermically in the treatment of syphilis. Average dose, gr. i (0.06 gm.).

The typical use of mercury as an alterative is in the treatment of secondary syphilis. As it is desirable to obtain its full influence as soon as possible, the ointment or the oleate may be rubbed into the skin freely. Aside from these, the non-cathartic preparations may be employed internally. Blue mass and calomel are seldom given in syphilis, but are valuable cathartic agents.

The constitutional symptoms produced by mercury, with the treatment of the same, are discussed in the article on Antiseptics. (See also the article later on Syphilis and its Treatment.)

Iodum.—IODINE [I].—This substance is not commonly administered in its free state internally, because of its irritating character. It is, however, a valuable alterative, and may be taken in large quantity in non-irritant

combinations. The iodides, which contain a large proportion of iodine, constitute a distinct group of general alterative agents, the most useful of which is sodium iodide.

Sodii Iodidum [NaI].—Estimated by the atomic weights of its components, this salt contains about 85 per cent. of iodine. Being much less irritating than iodine, it furnishes the means of getting a large amount of the latter into the system without much disturbance. This salt is used in the treatment of acute asthma, in chronic rheumatism and other conditions of tissue alteration, but its most extensive use is in tertiary syphilis. Sodium iodide possesses advantages over potassium iodide in the following points: It contains more iodine. It is slightly more soluble. It is less irritating, sodium being better tolerated by the system than is potassium. (See article below on Syphilis and its Treatment.)

Potassii Iodidum [KI].—Potassium iodide has about 76 per cent. of iodine in its composition. Its uses are the same as those of the sodium salt.

Other iodides are useful according to the particular combinations employed. The following are some of the most important preparations in frequent use:

Syrupus Ferri Iodidi.—Syrup of Iodide of Iron.—This is a very valuable preparation for use in the so-called "scrofulous" conditions. It may be taken for an indefinite period by children who show the characteristic enlargement of lymph nodes.

Arseni Iodidum [AsI_3].—Arsenous iodide is used chiefly in Donovan's solution, the liquor arseni et hydrargyri iodidi.

Syphilis and its Treatment.

Syphilis is a disease that is contagious and infectious in nature, one that may be met with in any walk of life, whether acquired innocently or through vicious conduct. It may be inherited in certain of its forms. It is a disease, moreover, of which its possessor may be ignorant, both as to its character and the source of infection, since the lesion of original infection, the chancre, may occur upon various parts of the surface of the body, where infection must have been purely accidental. The importance of this to the dentist is emphasized by the further fact, that the highly infectious secondary lesions are prominent in the mouth and throat, constituting here a danger to the dental operator directly, and to others indirectly. Syphilitic lesions are commonly painless,

which adds to the danger of non-recognition of the superficial mouth lesions.

The occasional occurrence of a chancre upon the hand of a dentist, justifies the advice that a constant lookout for the presence of the disease, in mouths coming under examination, should be exercised. This implies a certain degree of familiarity with the symptoms of the disease. Every opportunity, therefore, to study this disease should be improved. as a matter of personal safety and of duty to others. The dental specialist certainly owes it to his patients and to himself, to supplement his dental college course by a post-graduate study of syphilis in its chief clinical features. Without such thorough study of the manifestations of the disease, it is unsafe to attempt to diagnose its various lesions either of the mouth or skin, for the liability to error is very great; and even physicians of experience will often seek expert opinion as to the nature of a suspected lesion.

A word of caution is here appropriate. It may fall to the practitioner to discover a case of syphilis, by mouth symptoms, where it had not been suspected; but he must be exceedingly cautious about discussing this finding with his patient. He is dealing with a matter for which he has not been consulted, and in any suspicious acts or words of his, lie the possibilities of much unpleasantness. If the patient be an innocent wife a statement of his discovery might produce domestic discord. While she would have a most serious grievance, entitling her to our pity, a revelation could only add to her unhappiness. A suggestion to her to see her family physician for certain general conditions that you find evidence of, would be the proper course; and even this advice must be given tactfully, without arousing suspicion as to the probabilities in the case, for, after all, a mistaken diagnosis is possible. Any other course would also endanger professional relations with the family physician.

The point of greatest practical importance is, to be so careful in the manipulation of instruments as to avoid all danger of self-infection; for the saliva of a patient with secondary mouth symptoms may infect any abrasion of the skin that it comes in contact with. As a matter of course, all instruments and appliances used will be thoroughly sterilized immediately after the operation.

As a basis for study, a scheme is herewith given, which includes stages of the disease with their characteristic symptoms, and the application of remedies appropriate to each:

Syphilis, its Stages, Symptoms and Treatment.

Stages.	Symptoms.	Medicinal treatment.
Primary symptoms appear about three weeks after infections. *The lesion is very infectious.*	*a.* The chancre, located usually upon the genitals, but may occur upon any mucous or cutaneous surface. *b.* Enlargement of lymph nodes in all parts of the body, but not distinctive of this disease.	Salvarsan.
Secondary symptoms occur about six or eight weeks after infection, unless earlier treatment has arrested the disease. *The lesions in the mouth* (mucous patches) *are exceedingly infectious.*	*a.* A superficial rash, slight or abundant, distributed upon all regions of the body. *b.* Sore-throat. *c.* Mucous patches anywhere upon mucous membrane of mouth or throat, usually upon inner surface of cheeks or under tongue. *d.* Loss of hair, slight or marked.	Salvarsan. Mercury.
Tertiary symptoms may be prevented by treatment. In cases not treated the tertiary symptoms occur in from one-half to two years after infection, but they may be delayed. The lesions are only slightly infectious.	*a.* Deeper lesions of the skin, either single or multiple, but not of general distribution. *b.* Periosteal pains, chiefly in head and long bones, occurring mostly at night. *c.* Gumma, occurring mostly upon skin, in the nervous system, or smaller bloodvessels, but occasionally in any part of the system. *d.* Deep ulcers of the skin sometimes resulting from the breaking down of gummata. Usually single, or, if double, located upon symmetrical portions of body. *e.* Degenerations of circulatory or nervous systems. The arteries, brain and spinal cord are usual sites of degeneration.	Mercury. Sodium. iodide.

The discovery of the *spirocheta pallida,* believed to be the cause of syphilis, has rendered possible an early diagnosis in the primary stage, which permits the beginning of treatment at once, instead of waiting until the appearance of secondary symptoms confirms the clinical diagnosis, as was formerly the common practice. The introduction of salvarsan also has marked an advance in the efficiency of treatment, whereby the disease may be arrested early and a cure effected without the occurrence of secondary symptoms.

Outline of Treatment.—When a case is seen soon after the appearance of the chancre, the diagnosis should be made positive by the dark-field examination of scrapings or serum from the lesion. If this reveals the *spirochete*, treatment with *salvarsan* should begin at once. This drug is administered intravenously in normal salt solution; 8 to 12 injections are given, at first weekly for five or six weeks, then at intervals of a month or more. In addition to this, a course of mercury is begun early and both remedies are continued during the first year. The preparations of mercury now most commonly employed are the 50 per cent. ointment,

by inunction, pushed to the point of saturation, or salicylate of mercury gr. 1 (0.06 gm.) given each week by deep intramuscular injection. Other preparations may be employed, some using the bichloride hypodermically while others prefer the yellow iodide by mouth. During the second year the same remedies may be continued at intervals, or treatment may depend upon the results of Wassermann blood tests made every two or three months. In case the symptoms do not yield readily, and particularly in the *tertiary* stage, an iodide by mouth (preferably sodium iodide) may be added to the treatment.*

The question whether syphilis may be cured has been regarded as a debatable one, but it is one which now admits of an affirmative answer. The fact remains, however, that very many cases are not permanently cured. When we appreciate that a cure means the taking of medicines almost continuously for two years, and that syphilis is a disease whose symptoms yield very promptly to treatment, it cannot be expected that more than a small percentage of patients will continue treatment for the necessary length of time after they feel perfectly well.

A positive cure would mean a total of three years' observation, the first two with active treatment, and the absence of all symptoms with negative Wassermann tests through the third year. Marriage cannot be properly entered into without this thorough treatment and the three years of observation.

The following additional drugs are simply mentioned as representative of the class of *vegetable* alteratives:

Colchicum.—(For preparations, doses and uses, see Index of Drugs.)

Guaiacum.—(For preparations, doses and uses, see Index of Drugs.)

Sarsaparilla.—(For preparations, doses and uses, see Index of Drugs.)

Sarsaparilla must be regarded as the least valuable of this group. In fact, its value is so slight that it is seldom used alone. The proprietary "sarsaparilla tonics" all contain stronger agents, usually cathartic in action.

* The continued use of any iodide commonly produces a rash, consisting of pimples upon the face and elsewhere, which is believed to be nature's efforts to eliminate iodine. This is the chief symptom of iodism, or saturation with the drug.

CHAPTER XVII.

SEDATIVES.

A SEDATIVE is defined to be an agent that diminishes the activity of an organic function or process, the term *depressant* being equally applicable. All sedatives may be poisonous when given in large dose; and the toxic symptoms usually include narcosis. The division of the large list of sedative agents into groups designated by the terms arterial, nervous, etc., is a convenience, and helps to fix their characteristic action, but no distinct lines can be drawn between the groups. The terms point rather to the most prominent features of their action. (See classification, page 37.) In a practical sense the term applies to effect but not always to action. Stimulation of inhibition may produce a slowing or restraining effect, which we may call depression induced indirectly by stimulation. Instances of this kind are well illustrated in the action of aconite, as Plate XIV shows. Most sedatives, however, produce their effects by a direct depressant action upon either nerve or muscle tissue.

As a rule, children bear the moderate action of sedatives very well. The nervous system during childhood is so sensitive and responsive, that disturbed function in most cases calls for depressant rather than stimulant treatment.

Cold must be given a prominent place among the arterial sedatives. Just as the application of heat acts as a general stimulant, so the application of cold produces the opposite effect. Hyperemias and acute inflammations, whether in and about a tooth or elsewhere, injuries to tissues leading to extravasation of blood, cardiac and cerebral excitement, all may be greatly relieved by the application of cold. In this class of conditions, however, the rule should be recognized of employing either cold or heat according to which affords the most relief. Methods of applying cold are: the full or partial cold bath, the Leiter coil through which ice-water is allowed to run, the ice-bag, and the application of liquids that evaporate rapidly. The employment of freezing methods belongs to another chapter.

Depletion of the Circulation, whether by bloodletting, sweating or active catharsis, is another means of reducing circulatory activity, in

PLATE XIV.

ACONITE.

The tuber of A. Napellus.

The alkaloid Aconitine represents the drug fully, but is the most poisonous substance of its class. Therefore it is seldom used internally.

Classified as:

Arterial depressant.
Cardiac depressant.
Nerve depressant.
Antipyretic.

Physiologic action:

Nervous System.

Brain. No influence upon cerebrum.

Medulla. Stimulates vagus center. Probably depresses respiratory center.

Spinal cord. Influence uncertain.

Sensory nerve endings are depressed after a period of slight stimulation.

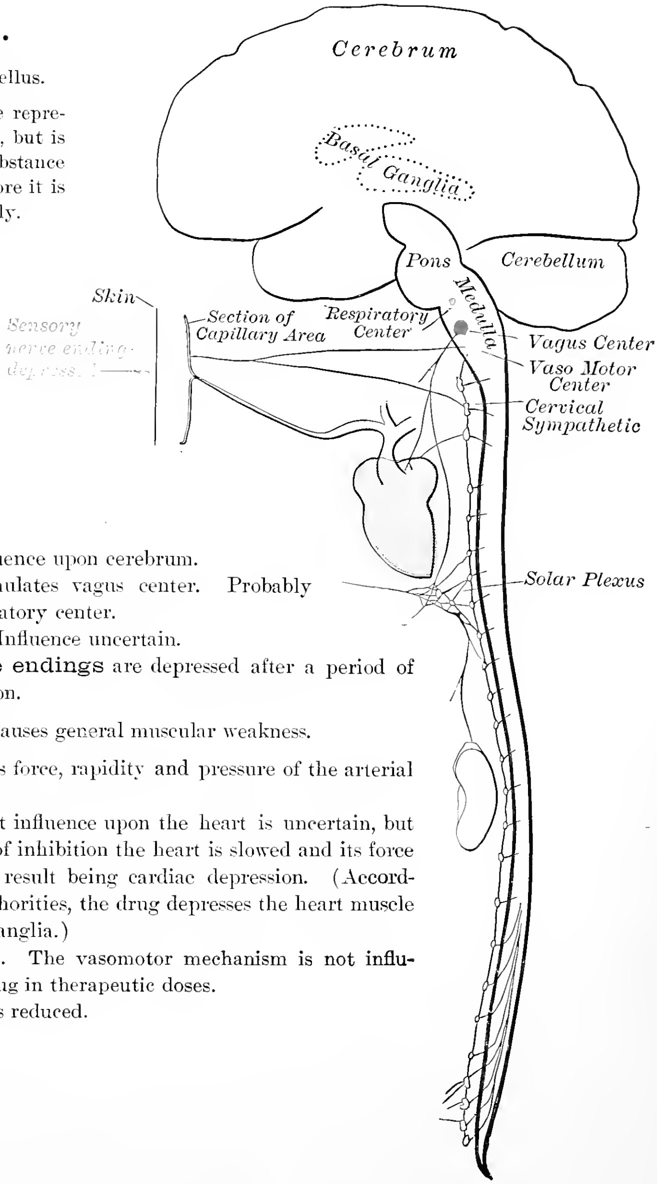
Muscular System. Causes general muscular weakness.

Circulation. Lessens force, rapidity and pressure of the arterial current.

Heart. A direct influence upon the heart is uncertain, but by stimulation of inhibition the heart is slowed and its force weakened—the result being cardiac depression. (According to some authorities, the drug depresses the heart muscle and its motor ganglia.)

Capillary area. The vasomotor mechanism is not influenced by the drug in therapeutic doses.

Temperature is reduced.



The red color indicates the stimulant action of Aconite upon the vagus center, which causes slowing of the heart's action. The blue color indicates the depressant effect of the drug.

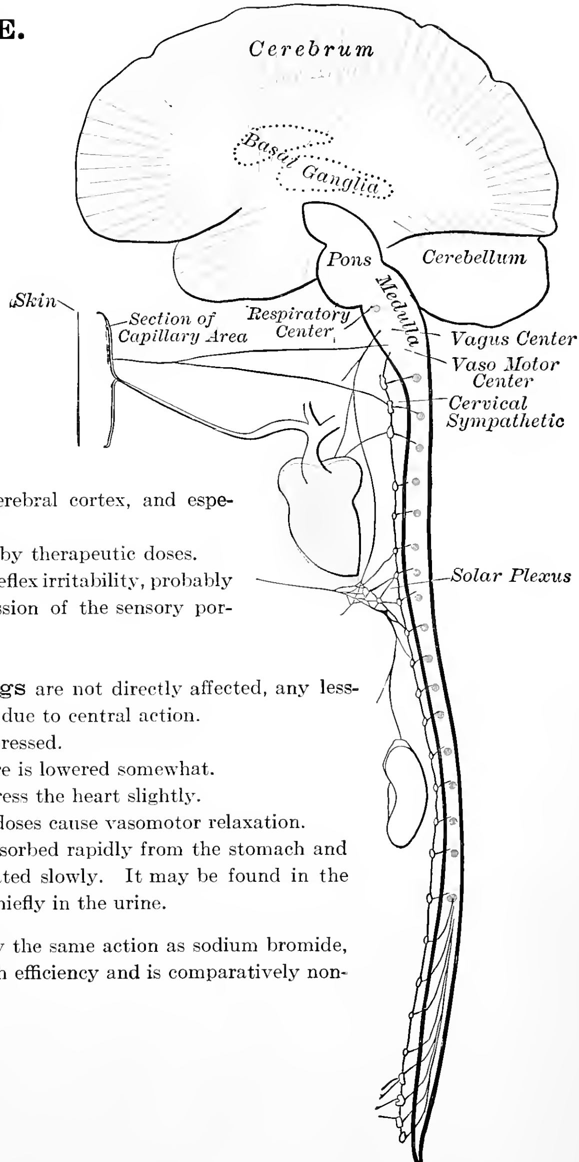
SODIUM BROMIDE.

[NaBr]

[This drug is regarded as the typical and most important agent of the group of bromides.]

Classified as :

Cerebral depressant.
Nerve depressant.
Antispasmodic.
Anaphrodisiac.



Physiologic action:

Nervous System.

Brain. Depresses the cerebral cortex, and especially the motor areas.

Medulla. Not affected by therapeutic doses.

Spinal cord. Lessens reflex irritability, probably mainly through a depression of the sensory portion of the cord.

Sensory nerve endings are not directly affected, any lessening of sensation being due to central action.

Sexual function is depressed.

Circulation. Arterial pressure is lowered somewhat.

Heart. Large doses depress the heart slightly.

Capillary area. Full doses cause vasomotor relaxation.

Elimination. The drug is absorbed rapidly from the stomach and intestines, but is eliminated slowly. It may be found in the several excretions, but chiefly in the urine.

Other bromides have essentially the same action as sodium bromide, but the latter possesses a high efficiency and is comparatively non-irritating.

The blue color indicates the sedative effects of the Bromides, their action upon the nervous system being much more important than that upon the circulation.

addition to which effect these measures also reduce toxemia, when that is a factor.

Of the medicinal agents the most typical ones of the several groups are here presented.

Aconitum. (Plate XIV.)

This drug is used in fevers and inflammations, to reduce arterial pressure. The tincture is used internally, either 5 to 15 minims (0.30–1 mil) several times daily, or in two-drop doses hourly until the effect is secured. With an equal part of tincture of iodine, the tincture is used as an application in pericementitis and pulpitis. The alkaloid **aconitine** is applied locally in form of the oleate in the treatment of neuralgias, and in obstinate cases it may be given internally in doses of gr. $\frac{1}{400}$ (0.00015 gm.).

Veratrum Viride and **Veratrine** have an action which resembles closely that of aconite.

(For preparations and doses, see Index of Drugs).

The uses of these are very similar to those of aconite. In addition veratrum viride is used to reduce arterial pressure in puerperal convulsions.

Acidum Hydrocyanicum Dilutum.—(See Index of Drugs.)

The preparations of wild cherry (*Prunus virginiana*) owe their sedative value to the presence of a small quantity of hydrocyanic acid. These are useful as excipients in cough mixtures; but when a decided effect from definite dosage is desired, the dilute hydrocyanic acid (2 per cent.) is used in doses of 1 to 2 minims (0.06–0.12 mil). The strong hydrocyanic or prussic acid is never used, as it is too poisonous even to manufacture.

Bromides. (Plate XV.)

Sodii Bromidum.—Sodium Bromide [NaBr].—The sodium salt represents the group well, and is entitled to preference over the potassium salt, as it contains more bromine and is better tolerated. Bromides are freely soluble in water and in alcohol. Since they are quite salty to the taste they must be given largely diluted. The average dose is gr. 15 (1 gm.).

The bromides are used in any conditions where there is cerebral or nervous excitement; in headaches, injuries to the brain, meningitis, hysteria, in epilepsy and other convulsive disorders; to control vomiting of reflex or cerebral origin. They are of special value in the nervous

and febrile disturbances that occur so readily during infancy. They may be given freely, but always well diluted so as not to irritate the stomach.*

The importance of sedatives in the management of first dentition leads to a brief consideration of that subject following the antipyretic group.

ANTIPYRETIC GROUP.

These synthetic agents are coal-tar derivatives, all of which occur in the form of white crystalline powders.

As antipyretic sedatives they have power to lessen temperature in fever, and in addition they have anodyne properties. In fact, since they have come to be recognized as sedatives, being on that account inadmissible in the severe fevers, they have found their most extensive use in the treatment of headaches, neuralgias and myalgias. They differ in their activity and safety.

Antipyrina [$C_{11}H_{12}N_2O$].—Average dose, gr. 5 (0.3 gm.). This is the mildest in action and also most soluble. It is of some value as an antispasmodic in the treatment of infantile convulsions and whooping-cough.

Incompatibility.—Antipyrine is incompatible with *spirit of nitrous ether* and with solutions of *carbolic acid.*

Acetphenetidinum.—PHENACETINE [$C_{10}H_{13}NO_2$].—Average dose, gr. 5 (0.3 gm.). This is more powerful than antipyrine, but comparatively safe. It is practically insoluble in water.

Acetanilidum [C_8H_9NO].—Average dose, gr. 3 (0.2 gm.). This is the most powerful of the group and least safe. It is sparingly soluble in water. It has the power of producing alterations in the blood that may cause a decided appearance of cyanosis, when full doses are taken repeatedly, or too large quantity in a single dose. It must be used cautiously, if at all, and never continuously for any length of time. The compound powder† is a useful internal analgesic. The caffeine in this may aid the action of the acetanilid, but it chiefly antagonizes its

* While the bromides in their ordinary uses are without danger, it should not be concluded that they are incapable of doing harm. Their prolonged use is not desirable, because they certainly do depress cerebral and nerve functions. The only unpleasant symptom commonly attending their prolonged use is the occurrence of pimples upon the face and elsewhere, which is believed to be nature's effort to eliminate bromine.

† *Pulvis Acetanilidi Compositus.* (N. F.)

	Gm. or mils.	
℞.—Acetanilidi	7	
Caffeinæ	1	
Sodii bicarbonatis	2	—M.

Of this the dose is 1½ to 8 grains (0.10–0.50 gm.).

depressant action upon the nervous system and heart. Locally, acetanilid is used as an antiseptic powder.

Acid, Acetylsalicylic.—ASPIRIN (not official).—Dose, gr. 2–10 (0.12–0.60 gm.). This drug has come into popular use under the proprietary name *aspirin*, as a remedy for headache and for various slight pains. It should be employed under the chemical name.

First Dentition Complications and Their Treatment.

It has been remarked that children bear sedatives relatively better than they do stimulants. The basis of this fact is found in the more sensitive nervous system of the child. If we compare the size of the brain at birth with the total weight of the body, we find that its relative size greatly exceeds that of the adult brain. At the same time its function is more complex in that it is concerned with the process of development, which becomes less active later on.

In consequence of this greater sensitiveness of the child's nervous system, impressions are magnified; not only do slight mental impressions beget fear or emotional outbreak, but slight nerve irritation which in an adult would be unnoticed, or, at most, would cause slight discomfort, in a child may produce fever and convulsions. Accordingly, a stimulant that acts through exciting or irritating a function or tissue will disturb rather than soothe, while a sedative will lessen the sensitiveness of nerve tissue and prevent the disturbances of function. Although occasionally so much depression may occur as to call for stimulants, as a rule they may be dispensed with in childhood, while sedatives hold a place of supreme importance, both as agents to prevent and to control the serious nervous disturbances that occur so easily during that period of life.

But the common causes of infantile disturbances are not external, but rather the irritations that proceed from functions abnormally performed within the body. These irritations may be of great variety; but as we see the extreme sensitiveness gradually disappear with the development of the child, we recognize that the maximum of susceptibility to irritation exists early, or during the period corresponding to first dentition. We must be reminded that during this period the whole digestive tract is being prepared for a more complex function, that of digesting food of firmer quality and greater variety. From the teeth downward the provisions for solution and absorption of food are being developed and adapted, and throughout there is connection with the same sensitive, directing and controlling central nervous system. This

is often shown very emphatically by the occurrence of vomiting or convulsions after the self-indulgent parent has enjoyed seeing the infant sit at the table and partake of the common family dishes, for which its digestive apparatus has not yet been prepared.

Of all of the developmental changes, the process of eruption of the teeth is the most visible; and it has, therefore, been blamed too indiscriminately for the disturbances that often coincide with it. It is so easy to satisfy anxious inquiry by the statement that the convulsion in a given case is due to teething, or, if that is improbable, to suggest that the child may have worms.

Without denying for a moment that abnormal dentition may be the cause of most serious disturbances, we must take a comprehensive view of the developmental diseases of infancy and not be too much influenced by what we may see at either end of the digestive tract. Teething and worms each have a pathologic importance, but we must not allow them to usurp attention that belongs to factors less apparent, but undoubtedly more important in many cases. We must hold *improper diet* to be an influence of first importance, and this refers not only to character of food, but to quantity and to intervals of feeding as well. Fermentation and putrefaction of food materials, and even infection in the intestinal tract, are prominent factors of disease at any age; but in the sensitive child, with full digestive capacity undeveloped, such factors are of superlative importance.

There is, however, occasionally seen a case of the most serious general disturbance, where dentition and the digestive function appear to be normal, that must be attributed to a special susceptibility or an abnormality in the nervous system itself. Again, we are convinced of the prominence of the central nervous system as a primary factor, when we see a child of unstable nervous constitution have a convulsion from a cause that a normal child will successfully resist.

These considerations bring into prominence the part of treatment that refers to the nervous system. It involves temporary prophylaxis as well as relief, and includes daily supervision of the child's diet and habits, with the judicious use of sedatives in order to lessen the irritability of nerve centers, so that they may respond less readily to irritating impressions.

More important still is the prophylaxis that fortifies the nerve centers by increasing their stability or tone. Hygienic measures, including an abundance of fresh air, daily bathing with tepid or cold water, and proper feeding, meet this requirement.

Probably the majority of children suffer with irritability and feverishness at some time during first dentition. As a rule the daily discomfort becomes more marked as the day advances, until midnight or later, when sleep may occur with frequent interruptions. Convulsion or spasm often occurs in the severer cases. The treatment of the condition will include the hygienic measures previously mentioned. The child should be taken out into the open air as much as is possible during the day as a matter of routine prophylaxis. Fever and fretfulness may be lessened by cold sponging or the cool bath. Medicines may not be needed in the early part of the day, but later, as the irritability increases, the bromides may be given freely and continued until the child rests. If the gums show great hyperemia over advancing teeth, scarification by means of a clean finger-nail or the point of a well-guarded lancet may afford much relief, but indiscriminate lancing of the gum is not to be advised.

To refer again to the medicines that are useful, both arterial and nerve sedatives have their place, according to the predominance of vascular or nervous disturbance. The typical arterial sedative drug is aconite. This may be given in form of the tincture, in a dose of one-half drop every hour until the circulatory excitement has lessened. Spirit of nitrous ether may be combined with it for the purpose of inducing sweating, the occurrence of which will reduce the fever.

A suggestive prescription for a child one to two years old is as follows:

	Gm. or mil.	
℞.—Tincturæ aconiti	1	(♏xv)
Spiritus ætheris nitrosi	30	(f℥j)
Glycerini	15	(f℥iv)
Aquæ cinnamomi . q. s. ad	60	(f℥ij)—M.

Sig.—One-half teaspoonful in water every hour until better.

The indications for this combination would be a full, rapid pulse with fever, and the medicine should be lessened or discontinued when these symptoms abate. Aconite must be used with due care, for it is a poisonous drug in excessive dose; so the precise indications for its use and the favorable result of its action should determine the extent of its employment in any case.

In most cases, the danger of convulsions, and the irritability of the nervous system, can be removed by the bromides, whose action is perfectly safe. Their use is addressed to the nervous element, which is usually very prominent, while the circulatory disturbance is secondary and incidental. Therefore, the use of a bromide will, on the whole,

be found most satisfactory, because it meets the primary indication of lessening the sensitiveness of the brain centers and, at the same time, can be used continuously in full doses without danger. Sodium bromide is the typical agent of the group, but it must always be given well diluted, so as to avoid irritating the stomach. The writer has never found the drug to cause vomiting when given freely diluted. It may be given in a dose of 5 to 10 grains (0.30–0.60 gm.) to a child one year old *in the emergency of a convulsion,* but the dose for continuous administration is 1 to 3 grains (0.06–0.20 gm.). The following formula is simple and useful:

		Gm. or mil.	
℞.—Sodii bromidi		2	(gr. xxx)
Syrupi		15	(f℥iv)
Aquæ cinnamomi	q. s. ad	60	(f℥ij)—M.

Sig.—A teaspoonful every hour while restless.

The above formula may answer every purpose of necessary medication in the simple irritability of the period of first dentition. Following the directions previously given in respect to hygienic treatment, the bromide need not be given until the beginning of the daily period of increased irritability, which occurs toward evening. Then it may be given hourly until the child is able to rest. It is then advisable to stop the medicine until the next afternoon, or, at least, to reduce it to longer intervals of administration during the morning.

A free purge, by the use of castor oil, is usually proper also, the dose being 1 to 2 teaspoonfuls (4–8 mils) or more, according to age.

Convulsions.—When spasms occur, the twitching or stiffness of the muscles is attended by unconsciousness. This shows that the brain is concerned in the effects of the irritation, wherever the latter originates. The condition must be treated as an emergency, the aim being to restore consciousness and relieve the convulsion. The head is usually hot, while the extremities may be cold. The treatment will embrace several measures:

1. To lessen the hyperemia and sensitiveness of the brain.
2. To remove the source of irritation, or lessen its severity.
3. To stop the convulsion directly, if that result does not follow the treatment under 1 and 2.

Under the first heading we employ means of bringing blood to the surface of the body, such as the hot (very warm) bath to the whole body except the head. If the latter is hot, cold applications should be made to it, as this will aid in securing the same object by driving the blood *from* the brain. Mustard flour (1 to 4 teaspoonfuls, mixed first with a

little cold or tepid water) may be added to the hot bath for a pronounced rubefacient effect.

Meanwhile, treatment coming under the second heading should be employed. While the convulsion is present it may not be possible to at once remove the irritation, which may be in the digestive tract; but the severity of its effect upon the brain may be lessened by the administration of sedatives. An excellent combination is that of sodium bromide and antipyrine, the latter having both antispasmodic and antipyretic value, and producing also a tendency to perspiration. A combination, giving the emergency dose of sodium bromide as 5 to 10 grains (0.30–0.60 gm.) and of antipyrine as 1½ to 3 grains (0.10–0.20 gm.) according to age, is here given:

	Gm. or mil.	
℞.—Sodii bromidi	10	(ʒijss)
Antipyrinæ	3	(gr. xlv)
Glycerini	10	(fʒijss)
Aquæ menthæ piperitæ q. s. ad	60	(f℥ij)—M.

Sig.—One-half to one teaspoonful; may repeat in one hour.

If the child does not swallow, as is apt to be the case, this must be given carefully, a few drops at a time.

A full dose of castor oil should be given, if swallowing is possible, so that any irritant in the digestive tract may be carried onward. It is not advisable to give an emetic during a spasm, for fear of vomited matter being drawn into the trachea.

If relief does not follow in say half an hour, treatment coming under the third heading may be employed, and this will usually be the cautious use of chloroform by inhalation, the object being to relieve the spasm by direct action upon the brain, with which result sleep takes the place of the coma. From this sleep the child may awake relieved, but in severe cases it may still remain in the convulsion. Spasms can usually be controlled by chloroform, but its continuous inhalation is in itself dangerous, so that reliance for permanent relief must be placed upon the other measures that remove the source of irritation, that relieve cerebral hyperemia, and that lessen the irritability of the brain centers more permanently.

Chloral hydrate is often used by rectum, in dose of a few grains (1–5), when convulsions are persistent.

For treatment beyond the emergency period, the bromide and antipyrine may be continued at the intervals necessary to prevent restlessness and fever. A cathartic should be employed, unless previously given, to ensure emptying of the digestive tract, where the irritation may have

originated. For this purpose castor oil is our first choice, being efficient and harmless. Succeeding the hot bath, the child should be wrapped in hot blankets, in order to keep the blood toward the surface and to favor sweating.

If dentition is found to be abnormal or difficult, and teeth are nearly ready to appear, the gums may be scarified as mentioned before. But cutting the gums over teeth that are not likely to appear for several months is questionable practice, as the tissue will rapidly heal, and may even present the additional barrier of scar tissue to the later progress of the teeth. When, however, the gums are very much swollen and congested, scarification may be advisable independently of the state of progress in the eruption of the teeth.

Other means of accomplishing the objects set forth above may be employed; simply the outline of common practice is here given. In the cases that present an evident infection, the treatment will, as a matter of course, vary according to its nature and the indications it furnishes.

Chloralum Hydratum. (Plate XVI.)

CHLORAL [$C_2HCl_3O—H_2O$].—Chloral hydrate is a typical hypnotic. It is used to induce sleep and to relieve convulsions. While at one time it was our only efficient hypnotic, it has been supplanted to a considerable extent by the newer and safer agents. It does not relieve pain in safe doses. Care must be taken not to exceed the safe dose, gr. 5–20 (0.30–1.30 gm.), as it may easily be poisonous.

Drugs having similar action:

Sulphonmethanum.—SULPHONAL.

Sulphonethylmethanum.—TRIONAL.—These drugs are safer than chloral but slower in action. Trional is more soluble than sulphonal, therefore usually preferred, but either must be given several hours before the effect is desired. Dose of each, gr. 15–30 (1–2 gm.).

Opium and its Alkaloids. (Plate XVII.)

Opium is the concrete exudation obtained by cutting the unripe capsules of the opium poppy, *Papaver somniferum*. It contains, in its fresh, moist condition, at least 9.5 per cent. of morphine (when dried about 10–10.5 per cent.), besides a number of other alkaloids.

This drug, in its simple form, in its preparations, or as represented by its chief alkaloids, *morphine* and *codeine*, stands at the head of all agents

CHLORAL HYDRATE.

Dose: gr. 5–20 (Gm. .30–1.30).

Classified as:

Hypnotic.
Narcotic.
Spinal depressant.
Cardiac depressant.

Physiologic action:

Locally applied, it is somewhat irritant. Internally, it resembles chloroform in action, except that it is not anesthetic in safe doses.

Nervous System.

Brain. Depresses cerebrum. Induces sleep, but does not relieve pain.

Medulla. Depresses respiratory and vasomotor centers.

Spinal cord. Depresses reflex centers.

Muscular System. Causes general muscular weakness. Probably depresses muscular coats of the arterioles by direct action.

Circulation. Reduces arterial pressure in marked degree.

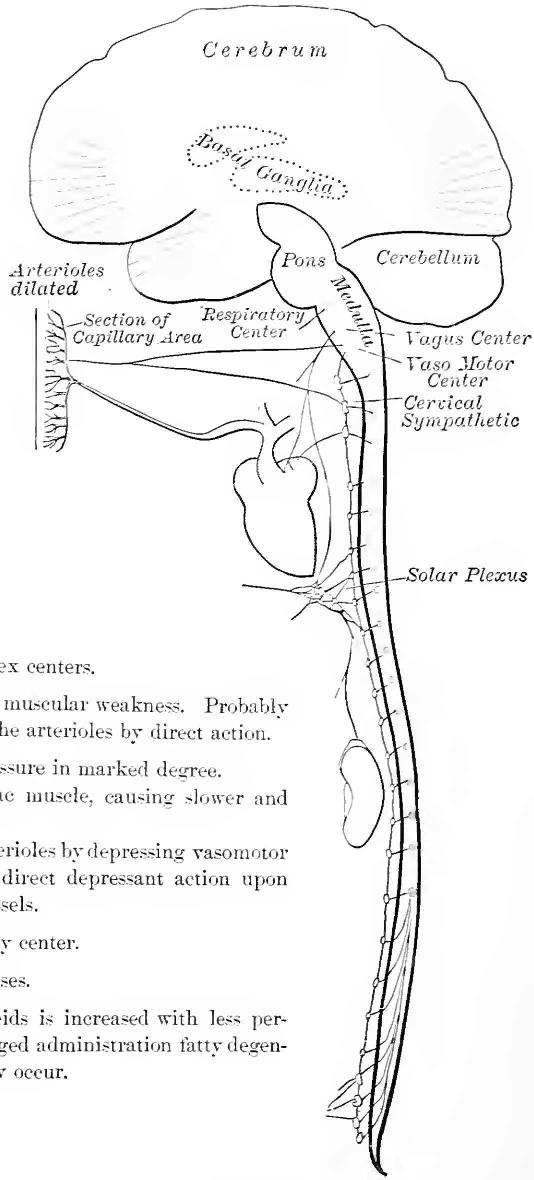
Heart. Depresses the cardiac muscle, causing slower and weaker action.

Capillary area. Dilates arterioles by depressing vasomotor center, and probably also by direct depressant action upon the muscular coats of the vessels.

Respiration. Depresses respiratory center.

Temperature. Reduced by full doses.

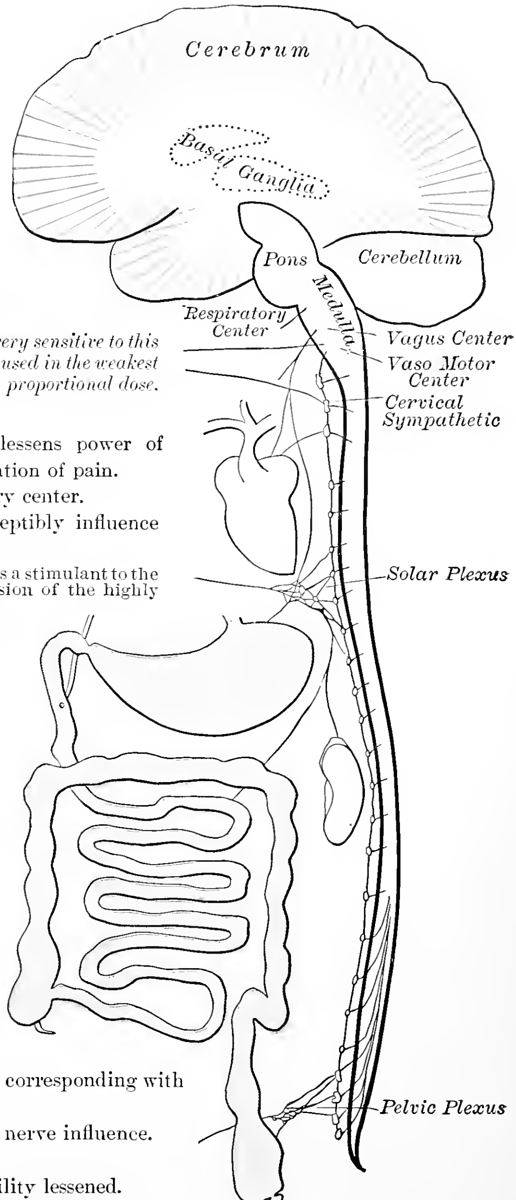
Metabolism. Destruction of proteids is increased with less perfect oxidation. With prolonged administration fatty degeneration of various organs may occur.



The blue color indicates the sedative effects of Chloral. The marked depressant action upon respiratory and vasomotor centers, and upon the heart, renders Chloral much more dangerous than the bromides, whose effects are similar in kind.

PLATE XVII.

MORPHINE.



In form of SULPHATE or HYDROCHLORIDE. Gr. $\frac{1}{8}$–$\frac{1}{4}$ (Gm. .008–.015).

Classified as:

Anodyne. Narcotic.

Physiologic action:[1]

The action of morphine is essentially that of a central nerve depressant, the local action of the drug, wherever applied, being almost *nil*. *Children are very sensitive to this drug, and, if needed, it should be used in the weakest preparations, and in less than the proportional dose.*

Nervous System.

Brain. Depresses cerebrum, lessens power of attention, and diminishes sensation of pain.

Medulla. Depresses respiratory center.

Spinal cord. Does not perceptibly influence the cord.

NOTE.—In the lower animals morphine is a stimulant to the spinal cord, but in man marked depression of the highly developed brain prevents any manifestation of spinal stimulation.

Nerves. The peripheral nerves are not affected by ordinary doses.

Muscular System. Not affected by ordinary doses.

Circulation. Not much influenced by ordinary doses.

Heart. Opinions differ. Any influence of a moderate dose must be slight and probably indirect. Large doses slow the heart by stimulating inhibition.

Capillary area. Not much influenced, except that the cutaneous area of the head and neck may show dilatation.

Respiration. Depressed to a degree corresponding with size of dose.

Eye. Pupils contracted by central nerve influence.

Digestive System.

Stomach. Secretion and motility lessened.

Intestines. Peristalsis is greatly diminished.

Elimination. Secretions generally are diminished, except the perspiration. The drug is partly changed in the system, but the greater part is eliminated by the gastro-intestinal tract.

[1] For poisoning by Opium or Morphine, see Table of Poisons and Antidotes.

for the relief of pain. It is the drug of first importance among poisons, and, next to alcohol, is the one most frequently used in the way of habit.

Whenever, therefore, it is used, poisoning and habitual use must be guarded against. It must be administered with some caution to persons whose susceptibilities are not known, and as a rule it should not be given to infants and young children. The prominence of the brain in childhood makes the child exceedingly susceptible to the influence of this drug, whose action is chiefly upon the brain and medulla.

Fortunately this drug is little needed in dental practice, because it has little or no local action. Its inutility to relieve pain by local application has been discussed in connection with arsenic. Practically the only conditions in which it is called for are severe pulpitis or pericementitis, which fail to be relieved by ordinary local treatment. Here a few small doses of the drug may be *given* to the patient, but it should *not be prescribed* in any quantity, for fear that the relief obtained might lead to an easy later resort to the drug, with formation of habit.

In the rare cases where it becomes necessary to administer the drug to a child, a much smaller dose must be used than that which the rule would allow.* The preparation used mostly with children is the *camphorated tincture of opium*, commonly known as paregoric, which contains only 0.4 per cent. of opium. *The rule should be not to give opium or morphine to children.*

Persons who take this drug habitually acquire a tolerance for it, that permits them to take very large doses. While the usual dose of morphine is $\frac{1}{4}$ of a grain, a victim of the habit may come to use 10, 20 or 30 grains daily. Indeed, there is the need of increasing doses in order to maintain the original effect, even where it is taken for a comparatively short time for the relief of pain. This shows that the tolerance of the drug begins early. Again, when the system has become accustomed to its action, it is usually difficult to stop the use of the drug without some discomfort in the way of unrest, that is at once relieved by its readministration. On these accounts it is very easy to acquire the opium or morphine habit, and very difficult to overcome it without the fullest coöperation of the victim with the medical adviser; and with the habit once thoroughly established, subjection to the discipline of a hospital will usually be required in order to succeed. (For poisoning by opium or morphine, see Table of Poisons and Antidotes.)

* See Cowling's rule in chapter on Prescription Writing.

Morphina [$C_{17}H_{19}NO_3+H_2O$]. — This alkaloid was isolated from opium and described by Sertürner in 1816, and was the first to be discovered of the whole class of alkaloids. It has stood during the years since as the most representative principle of opium; and, while its action varies slightly from that of the whole opium, the uses of the two substances are identical, except that for hypodermic use a *morphine salt* is always employed. Being a very powerful drug, morphine has to be used with caution. For its action in detail, see Plate XVII. Its official salts are:

Morphinæ Hydrochloridum, soluble in 17.5 parts of water.

Morphinæ Sulphas, soluble in 15.5 parts of water.

The average dose of each of these is gr. $\frac{1}{8}$ (0.008 gm.), which may be increased as needed up to twice the quantity, in their ordinary use.

Codeina [$C_{18}H_{21}NO_3+H_2O$].—Soluble in 88 parts of water. Codeine is less powerful and less depressing in action than morphine, and its after-effects are less unpleasant. Its official salts are:

Codeinæ Phosphas, soluble in 2.3 parts of water.

Codeinæ Sulphas, soluble in 30 parts of water. The average dose of each is gr. $\frac{1}{2}$ (0.03 gm.)

CATHARTICS.

Cushny classifies cathartics into three groups:

1. Mild aperients, the castor oil group.
2. The anthracene purgatives.
3. The jalap and colocynth group.

These correspond largely to groups A, B, and D as given below. The diagrams are intended to show the different ways in which cathartics may act.

It is not possible to classify strictly, as the action of some is too extensive to be limited to one group.

The numbers indicate the diagrams that represent what is believed to be the most prominent action in case of each drug, not always the complete action.

[For preparations and doses, see Index of Drugs.]

Group A. LAXATIVES.

Fruits. (1)
Sugar.
Sulphur.
Purges in small doses.
Glycerin (by enema). (2)

Group B. PURGES.

Aloe. (1)
Mercurials. (4)
Oleum Ricini. (4)
Rhamnus Frangula. (1)
Rhamnus Purshiana. (1)
Phenolphthalein. (4)
Rheum. (1)
Magnesia. (3)
Senna. (1) (4)

Group C. HYDRAGOGUES.

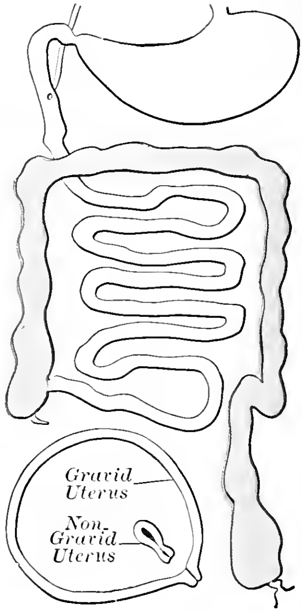
Salines.

Magnesii Citras. (3)
Magnesii Sulphas. (3)
Potassii Bitartras. (3)
Potassii et Sodii Tartras. (3)
Sodii Phosphas. (3)
Sodii Sulphas. (3)
Elaterinum. (4)
Jalapa. (4)
Senna. (1) (4)

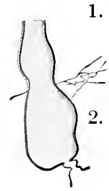
Group D. DRASTICS.

Colocynthis. (5)
Elaterinum. (3) (4)
Jalapa. (3) (4)
Cambogia. (5)
Oleum Tiglii. (5)
Podophyllum. (5)
Scammonium. (5)

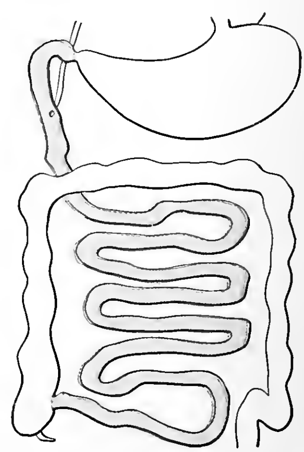
The red color shows the site of action, and indicates stimulation of motility or secretion.



1. Motility of large intestine stimulated.



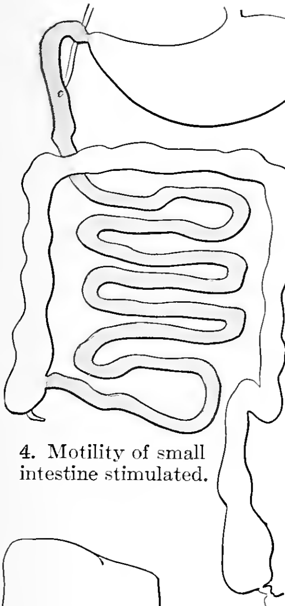
2. Motility of rectum stimulated.



3. Secretion stimulated.

PLATE XVIII.

CATHARTICS.



4. Motility of small intestine stimulated.

The natural provision for intestinal evacuation includes three factors:

First. A certain amount of indigestible matter in the food.

Second. Peristaltic motion from the stomach downward.

Third. A certain degree of fluidity of contents.

A decrease of any one factor tends to constipation, while an increase tends to diarrhœa.

Cathartics act by influencing these several factors.

Laxative foods act by reason of their indigestible residue. Almost any cathartic may have simply a laxative effect when used in small doses.

Purges, by their irritating action, stimulate peristalsis, the milder ones acting mainly upon the large intestine (1). Some, in large doses, approach drastics in severity of action (5). The absence of bile diminishes the activity of podophyllum, jalapa, rheum, senna, and scammonium.

Hydragogues act in two ways:

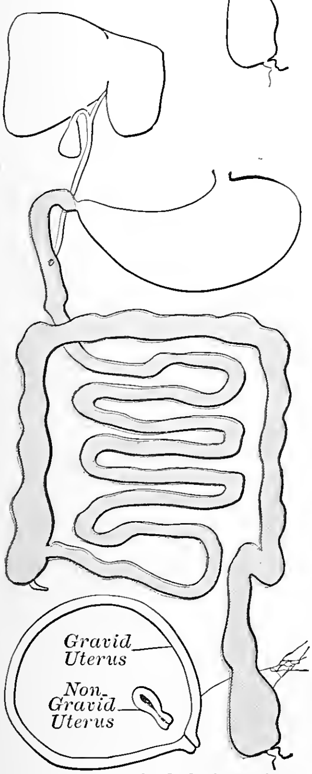
The less irritating *salines* cause a marked increase of fluid by determining a flow of serum from the blood into the intestine (3). A low blood-pressure diminishes their activity.

The more irritating hydragogues stimulate very promptly peristalsis of the small intestine, with the result that the fluid contents are hurried onward and absorption is lessened (4). Secretion also may be increased. Copious liquid stools result.

Drastics stimulate powerfully the peristaltic movement of the whole tract (5), causing prompt, frequent stools, with severe griping. In large doses they act as irritant poisons, and may cause contractions in the gravid uterus.

Cholagogues favor the flow of bile into the duodenum, probably through the increased peristalsis. The influence of cathartics upon the function of the liver seems uncertain and indirect.

The red color shows the site of action, and indicates stimulation of motility or secretion.



5. Motility of whole intestinal tract stimulated.

CHAPTER XVIII.

ELIMINATIVES.

A GROUP of functions that are liable to disorder in connection with any general disease, comprises those that secure the discharge of waste or used-up matters from the body. These functions are called eliminative, and the organs chiefly concerned in their activity are the skin, the kidneys, the intestines and the lungs. *Eliminatives* are those agents that increase the eliminative activity of these several avenues of excretion.

Cathartics are agents that induce active evacuation of the intestines. (See Plate XVIII.)

Diuretics increase the activity of excretion by the kidneys.

Diaphoretics are agents that induce sweating.

Emetics are agents that cause vomiting. Their action is not so purely eliminative, as vomiting is not a normal eliminative function, but rather a result of irritation, or a symptom of disease. Their eliminative value is seen mainly when a poison or foreign substance requires to be removed from the stomach.

Expectorants are agents that increase the secretion of the air passages. In a study of the subject of elimination, we observe a certain complementary relation between the activity of the skin and of the kidneys.

A certain amount of water, holding excretory matter in solution, passes out of the body daily, chiefly by the skin and kidneys; and, while the solids are separated from the blood chiefly by the kidneys, the amount of water which they excrete varies greatly, being influenced especially by the activity of the skin. In summer, when perspiration occurs freely, the urine is scanty in quantity but concentrated; while in winter, when the cool temperature lessens cutaneous elimination, the water passes out mainly by the kidneys, causing a large amount of diluted urine. In the application of diaphoretics and diuretics we should take into account this relation, for some agents will act in either way. For example, spirit of nitrous ether, when taken in the evening, with the skin being kept warm during the night, will induce sweating; whereas, when it is given in the morning, followed by exposure to a cool out-of-door temperature, it will act as a diuretic. To some extent bowel activity also may relieve the kidneys. We have, therefore, two resources in the direction of

vicarious elimination when the kidneys are disabled—viz., by catharsis and by diaphoresis; though they are only substitutes and much less efficient.

The lungs eliminate volatile substances chiefly.

DIURETICS.

Diuretics increase activity of the kidneys in several ways.

1. Some alter the composition of the blood by increasing its salinity. The potassium salts especially act in this way. Potassium is less needed by the system than sodium; therefore a moderate dose means an excess in the blood, which naturally passes out by the kidneys, carrying considerable water with it. This explains why potassium salts are diuretic while sodium salts are not. The most valuable for this purpose are the following:

Potassii Acetas.—This salt is deliquescent. Average dose, gr. 15 (1 gm.).

Potassii Citras.—This salt is deliquescent. Average dose, gr. 15 (1 gm.)

Potassii Bitartras.—Cream of Tartar.—Average dose, gr. 30 (2 gm.).

Potassii Nitras.—Nitre.—*Saltpetre.*—Average dose, gr. 8 (0.5 gm.).

Of these potassium salts, the acetate, citrate and bitartrate are harmless when given properly diluted, and their use may be continued indefinitely. The bitartrate is cathartic when given in large dose. The nitrate is used with caution, as it is believed to be more stimulating to the kidney.

2. Another class of diuretics act chiefly by increasing arterial pressure. In many cases where elimination is deficient, it is because the circulation is weak and the arterial pressure low; in fact, the balance of blood pressure has been transferred from the arterial to the venous side, which causes dropsy or edema. The best kind of diuretic here may be an agent that restores the balance of pressure to the arterial side, even though it does not directly stimulate the kidney structure. The following drugs act in this way:

Digitalis.—The leaves of *Digitalis purpurea.*

Strophanthus.—The seeds of *Strophanthus kombé* and of *S. hispidus.*

Sparteinæ Sulphas.—A liquid alkaloid from *Cytisus scoparius.*

Scilla.—Squill.—The bulb of *Urginea maritina.*

(For preparations and doses of these, see Index of Drugs.)

3. Still other diuretics act by stimulating the secreting structure of the kidney, leading to a better excretion of solids. These are sometimes called stimulant, or specific, diuretics.

Examples of this class are:

Spiritus Ætheris Nitrosi.—Spirit of Nitrous Ether.—*Sweet Spirit of Nitre.*

Buchu.—The leaves of *Barosma betulina* or of *B. serratifolia.*

Cubeba.—CUBEB.—The dried, unripe fruit of *Piper Cubeba.*

Oleum Juniperi.—OIL OF JUNIPER BERRIES.

Oleum Terebinthinæ.—OIL OF TURPENTINE.

Potassii Nitras.—*Saltpetre.*

Theobrominæ Sodio-salicylas.—*Diuretin.*

Uva Ursi.—The leaves of *Arctostaphylos Uva ursi.*

(For preparations and doses of these, see Index of Drugs.)

The above division into classes is convenient, but not absolute, as some diuretics act in more than one way. Such are classed according to their more prominent action.

DIAPHORETICS.

The agents that induce sweating are well represented by the following:

Spiritus Ætheris Nitrosi (with skin kept warm).

Pilocarpinæ Hydrochloridum.

Pilocarpinæ Nitras.

(For doses and uses, see Index of Drugs.)

Heat in form of hot-air cabinet bath, hot-air bed bath, hot mustard foot bath, and hot teas of various kinds drunk in good quantity, is a most important and probably the most reliable agency for inducing sweating.

EMETICS.

The agents that induce vomiting act either by irritating the mucous membrane of the stomach, causing reflex contraction of stomach, diaphragm, and abdominal muscles, or, by acting directly upon the vomiting center in the medulla, they stimulate the same motor activities.

The following act reflexly by irritating the stomach:

Sinapis.—MUSTARD.—The ordinary ground mixture of black and white mustard seed is employed, a tablespoonful or less stirred up in a glass of cold water.

Ipecacuanha.—The root of *Cephælis Ipecacuanha* or of *C. acuminata.*

Zinci Sulphas.—SULPHATE OF ZINC.

Cupri Sulphas.—SULPHATE OF COPPER.

Antimonii et Potassii Tartras.—TARTAR EMETIC.

The first three are commonly used, being reliable and safe. Sulphate of copper is more irritating, therefore capable of doing harm. Tartar emetic is also very depressing, and has often caused poisoning.

(For preparations and doses of these, see Index of Drugs.)

Common salt and powdered alum also are useful emetics.

Apomorphinæ Hydrochloridum.—HYDROCHLORIDE OF APOMORPHINE.—This is an artificial alkaloid derived from morphine. As it acts upon the vomiting center, it may be given hypodermically in cases of poisoning by opium or other narcotics, where the patient does not swallow. The dose hypodermically is gr. $\frac{1}{10}$ (0.006 gm.).

(See Index of Drugs.)

The use of emetics has lessened somewhat since washing out of the stomach (lavage) has become such a common procedure. The latter has the advantages of emptying the stomach without any delay and permitting a thorough washing of its walls.

The uses of *syrup of ipecacuanha* with children merit special attention. In cases of spasmodic croup it is employed, in emetic dose, for the purpose of securing complete relaxation of the respiratory apparatus, with relief of the spasm in the larynx. Also in the treatment of bronchitis in children too young to expectorate, its emetic action is employed in order to expel mucus from the air passages, where its accumulation interferes with breathing and provokes coughing. For both purposes mentioned syrup of ipecacuanha is given in doses of one-half to one teaspoonful (2–4 mils.), repeated in half an hour if necessary, the purpose being to induce vomiting.

EXPECTORANTS.

Expectorants increase the secretion of the air passages. Some of the emetic drugs, and especially the following, may be expectorant in smaller doses:

Ipecacuanha.—IPECAC.

Apomorphinæ Hydrochloridum.

Antimonii et Potassii Tartras.—TARTAR EMETIC.

(For preparations and doses, see Index of Drugs.)

Ammonia and ammonium preparations are largely eliminated by the air passages, and they at the same time stimulate the mucous secretion. The chief ones of value are the two following, the first of which is also a general stimulant, and used on this account in the more depressing respiratory diseases, such as pneumonia.

Ammonii Carbonas.

Ammonii Chloridum.

Other expectorants, stimulating in nature, include

Cubeba.—CUBEB.

Scilla.—SQUILL.

(For preparations and doses, see Index of Drugs.)

CHAPTER XIX.

ANIMAL DRUGS.

SUBSTANCES of animal origin have from time to time found a place in our materia medica. Some have fallen largely into disuse, such as musk and castor, of the antispasmodic class. More recently the digestive enzymes have been recognized as having a positive value and, while both pepsin and pancreatin are official, even their use has diminished very much with a better knowledge of the physiology of digestion. But the past decade has seen the fuller development of preparations of some of the ductless glands, representing internal secretions of the greatest importance to the nutrition and well-being of the body. These will be discussed as fully as the scope of this book demands. They are employed in the form of the dried gland or of an extract of the gland tissue and in case of the suprarenals an active principle (epinephrine) has been isolated.

Thyroideum Siccum.—*Dried Thyroids.*—The thyroid glands of animals used as food by man, dried and powdered. Average dose gr. 1½ (0.1 gm.).

This substance is absolutely essential in the treatment of conditions due to deficient thyroid secretion, the disease known as *myxedema* yielding very promptly to its use, while the more advanced state of malnutrition known as *cretinism,* if recognized early, shows the most remarkable improvement under its use. Since these conditions are due to deficiency of thyroid secretion, it follows that the treatment must be continued through life.

Suprarenalum Siccum.—*Dried Suprarenals.*—The suprarenal glands of animals used as food by man, dried and powdered. Average dose gr. 4 (0.25 gm.).

The value of this substance depends upon its power of stimulating, by local action, structures innervated by the sympathetic nerves, particularly the unstriped muscles of the arterioles and the accelerator terminations in the heart. For emergency stimulation of the circulation it is given intravenously, since administration by stomach or hypodermically produces very little effect.

The local action of this agent is very important in the treatment of

hemorrhage from small vessels and in connection with cocaine or other analgesics. In the latter use, chiefly by hypodermic injection with the analgesic, its vasoconstrictor action prevents rapid absorption of the latter, holding it to the desired locality, thus rendering its action more efficient and safer. The active principle of the suprarenal gland (epinephrine, Abel) is used largely in form of the 1 : 1000 solution called

Solution of Adrenaline Chloride* (not official).—This may be added to analgesic solutions, at the time of use, within the limit of the internal dose of ♏ 10–30 (0.60–2 mils). In nosebleed and other small hemorrhages this is one of our most valuable local agents.

Hypophysis Sicca.—*Dried Pituitary Body.*—The dried posterior lobe of the pituitary body of cattle. Average dose gr. $\frac{1}{2}$ (0.03 gm.).

The pituitary body seems to be related to the function of growth, its overaction causing an abnormal and excessive enlargement of part or whole of the body, the conditions known as acromegaly and gigantism. Its therapeutic value, however, depends chiefly upon its power to stimulate unstriped muscle, whereby it induces constriction of the peripheral arterioles, stimulates motility of stomach and intestines, increases the secretion of milk and stimulates uterine contractions. In ordinary doses it has little or no central action upon the nervous system. It is administered in solution either hypodermically or intravenously, since it has little effect when given by mouth. The official solution is

Liquor Hypophysis.—*Solution of Pituitary Body.*—Average dose: ♏ 15 (1 mil.).

Pituitrin, hypophysin, etc., are commercial extracts of the drug.

Serum Antidiphthericum Purificatum.—*Diphtheria Antitoxin.*

Serum Antidiphthericum Siccum.—*Dried Diphtheria Antitoxin.*—Average dose: hypodermic, 10,000 units; protective, 1000 units.

This agent consists of certain antitoxic substances obtained from the blood serum of the horse, after subjecting the animal to increasing doses of diphtheria toxin, whereby immunity against the toxin is secured. The purified antitoxin, as commonly used, either hypodermically or intravenously, has the antitoxic globulins dissolved in physiologic solution of sodium chloride and has a potency of not less than 250 antitoxic units per mil.

Antitoxin is now fully relied upon both in treatment of diphtheria and to immunize against the disease.

* This substance is also marketed under various other names, such as adnephrine, suprarenine, hemostasine, etc.

Serum Antitetanicum Purificatum.—*Tetanus Antitoxin.*

Serum Antitetanicum Siccum.—*Dried Tetanus Antitoxin.*—Average dose: hypodermic, 10,000 units; protective, 1500 units.

This agent consists of certain antitoxic substances obtained from the blood serum of the horse, after a process of immunizing the animal against tetanus toxin. Used commonly in the physiologic sodium chloride solution (purified form) it is found more efficient as a preventive than as a curative agent; hence, it is common practice to inject hypodermically a protective dose after any injury that presents the probability of tetanus infection. For some years past Fourth-of-July injuries have been thus treated, with the result that cases of tetanus, formerly very frequent after these injuries, have been reduced to a small percentage. Its use after the disease has developed is less successful, and here, as an aid to other treatment, it is administered intravenously or, better still, injected directly into the spinal canal. Tetanus antitoxin has a potency of 100 units per mil.

Pepsinum.—*Pepsin.*—White or yellowish scales or powder, being a mixture containing a proteolytic enzyme, obtained from the stomach-wall of the hog. It should digest not less than 3000 times its weight of egg albumen. Average dose, gr. 8 (0.5 gm.).

While meeting certain indications of deficient digestive power in the stomach, pepsin is now used much less than formerly. It is often given in an acid solution in imitation of the gastric juice.

Pancreatinum.—PANCREATIN.—*Extract of Pancreas.*—A cream-colored powder containing amylopsin, trypsin and steapsin, obtained from the pancreas of the hog or the ox. It should change not less than 25 times its weight of starch into soluble carbohydrates. Average dose, gr. 8 (0.5 gm.).

Since pancreatin contains at least three enzymes, it has a wider application to digestive diseases than does pepsin. It is administered usually in powder form, with addition of sodium bicarbonate to insure an alkaline medium for its action, in imitation of conditions found normally in the small intestine. In intestinal indigestion at any age it is found useful, and it is often employed to predigest (peptonize) food, especially milk, for administration either by mouth or by rectum.

It is regarded as irrational to use pepsin and pancreatin together, since the former requires an acid medium for its action, while the latter acts best in an alkaline medium.

CHAPTER XX.

DENTISTRY DURING PREGNANCY.

The decision of the question as to performing dental operations during gestation must usually rest upon the combined opinion of family physician and dentist. It is easy to formulate rules of practice, but these may just as easily be disregarded in the presence of an urgent condition. It must always be remembered that gestation is usually a normal, physiologic process, which should permit liberty of treatment within sensible limits instead of imposing too strict limitations.

The factors that form the basis for the exercise of caution are:

1. Increased nervous susceptibility of the pregnant woman, particularly in the early months.

2. Danger of disturbance of the process of gestation through shock or violence.

There may also be noted the prevalent belief that strong impressions upon the senses may be the cause of birthmarks.

This belief, though it has the support of some authorities, cannot be given any physiologic basis. The fact that no nervous connection exists between mother and embryo weighs heavily against it; for that fact requires the assumption that some blood condition of the mother is capable of influencing in a peculiar way some particular embryonic tissue; in other words, to exert a selective influence.

Assuming such an improbability, it still could not be believed that tissue once normally formed can be subject to such influence; therefore, it is safe to state that any detrimental impression can be potent, if at all, only during the early weeks of gestation, the time of conception doubtless being the most impressionable period.

The period of greatest liability to possible dangers of this kind being then at a time when it is as yet uncertain whether pregnancy exists, it, indeed, being oftentimes unexpected, it is evident that we can exercise practically no control in this matter; and for the dental practitioner to observe the general rules to be given later, should suffice as far as he can be concerned.

Coming to the practical question of dental operations, we recognize certain periods of greater susceptibility to disturbance. The first

three months constitute the period of greatest nervous instability, as shown by reflex vomiting, which occurs in the healthiest women as well as in the less vigorous. The system is accommodating itself to the new order of affairs. Certain organs are undergoing change to accommodate new or increased function. Latent weakness of organs is apt to become manifest. It is the period which usually determines whether accommodation and compensation can sufficiently occur, for it is the period of most frequent failure; which is to say that abortion occurs most frequently during the first three months.

This period once passed without accident, health and vigor improve, so that after the fourth month the state of health is often the best ever experienced. This satisfactory status continues to the end of gestation; except that during the last two months there is danger of premature labor being induced through shock or violence.

These considerations lead us to divide gestation, for our present purpose, into three periods, as follows:

1. First three months—the susceptible and accommodative period.
2. Fourth to seventh month inclusive—the period of vigorous health.
3. Last two months—the period of increasing discomfort.

During the first period any considerable operation should be avoided, unless absolutely necessary. Prolonged filling operations, or extraction of a tooth, had better be postponed until after this unstable period of accommodation and great susceptibility. But it must be plain that even the extraction of a tooth may occasion less disturbance than toothache prolonged through several days with sleepless nights. In case of an extraction being positively necessary, an anesthetic may be used at the discretion of the family physician.

From the foregoing it appears that the time of choice for dental operations lies within the second period, and preferably during the fifth and sixth months. At this time the general health is at its best and the danger of disturbing gestation at its minimum. There is no good reason why any necessary dental work should not be done during several months at this time. There should be every care taken to avoid the infliction of pain, and short sittings should be the rule. Anesthesia of short duration is admissible when necessary, the choice of agent to be left to the family physician. It should, however, be noted that all during gestation there is an essential tendency to toxemia upon slightest provocation, because of the extra demand upon nutrition and elimination. It is a question, therefore, whether any anesthetic should be used that will increase this tendency or add to its results. The exclu-

sion of air during the induction of anesthesia, as is common with nitrous oxide, should be avoided, as directly contributing to auto-intoxication, and this means that inhalers that do not allow free access of air, or those that require the rebreathing of expired air, should not be used.

In the third period a restrained posture in the dental chair for any length of time may mean serious discomfort. Add to this the danger, though slight, of provoking premature labor, and we are brought to the conclusion that dental operations should be avoided during the last two months, if possible. Where dental work seems necessary during this period, the operator should consult the family physician before undertaking the same; for it may be that there are unfavorable points in the patient's condition that are known only to her physician.

Care of the Mouth during Pregnancy.—Because of the abundantly observed fact that caries of the teeth makes rapid progress in the teeth of pregnant women, care of the mouth with a view to prevention of caries becomes very important.

It was earlier believed that the tooth structure suffered a change by giving up some of the mineral salts to meet the needs of the growing embryo. If this were true it would seem that Nature had shown herself seriously at fault in failing to provide sufficiently for the assimilation of materials that are very abundant in the foods commonly taken. However, it has been shown by Black* that the teeth of females during the period of life when child-bearing occurs, average slightly harder and denser than the teeth of males during the same period of life; and the conclusion follows that the prevalence of caries must be explained in some other way.

When we consider the active part that acids take in the production of caries, it is only necessary to point out that the usual vomiting of pregnancy, which occurs during the first three months, brings acid stomach contents daily, and oftener, into the mouth and in contact with the teeth, and we have the basis of a rational explanation of the rapid progress of caries. Also, with the attention fixed upon other matters, and with more or less general indisposition, the teeth are very likely to be neglected just at a time when they need extra care.

Upon the basis of this explanation the prophylaxis will be simple and efficient. If we are in a position to advise early, education of the patient comes first; then the simplest kind of an alkaline mouthwash, such as lime-water or saturated solution of borax or of sodium

* Dental Cosmos, May, 1895.

bicarbonate, used freely at frequent intervals and immediately after every occurrence of vomiting, and continued during the early months, ought to suffice in a special way. The usual directions as to general care of the mouth and teeth will, of course, be emphasized.

Unfortunately, even the physician is not consulted in the average case until the period most important for prophylaxis is past; therefore, every suitable opportunity of educating mothers and those likely to be mothers, upon these points, should be improved.

PART IV.

CHAPTER XXI.

PRESCRIPTION WRITING.

The writing of prescriptions is an art that requires practice for its perfection. Its basis must be a certain attainment in the knowledge of drugs, their activities and their doses, as related to their selection for certain diseases; also of their physical and chemical qualities as related to form of administration and possible combination with other substances. While it is easy to order a simple solution of a common substance, the forming of an original compound prescription, to suit a special condition, calls for the exercise of as much and as varied ability as does almost any function that pertains to the physician's duties. After the prescriber comes to a point in experience when his remedies are familiar and his own combinations of them are established, their prescription by him in any modification to suit special cases is comparatively easy; but to the beginner in practice, nothing is much more difficult than to write original prescriptions with any degree of confidence.

The art of prescribing is quite ancient, having been employed first by the physician to guide his assistant in preparing his medicinal mixtures, the office of physician having included also that of apothecary. Today, with pharmacy developed into a distinct profession, our prescriptions are intended to direct the preparation of a medicine to be supplied by the pharmacist to the patient, to be used according to the written directions of the prescriber. There is a marked contrast between ancient and modern prescriptions, in respect to their definiteness and simplicity. Reference to the works of Fallopius, who lived 1523–1562, furnishes an illustration of complexity in prescribing, in a formula written by him, which contains thirty-two different ingredients.

Since the sixteenth century we have learned enough about the human body and its diseases to know that it is unnecessary to exhaust our materia medica in prescribing for any one disease, and, with a more

definite knowledge of the action and effects of drugs, we find that only a few agents can be employed to real profit in meeting a pathologic condition. Hence, our prescriptions of today approach the extreme of simplicity, usually containing not more than three or four ingredients. The term "shotgun" prescription is derisively applied now to a formula containing a large number of substances, upon the supposition that it is expected to hit somewhere. A certain idea of definiteness, however, is traced back to Asclepiades (about 100 B.C.), who is credited with formulating the object of treatment to be to *cure quickly, safely* and *pleasantly* (*curare cito, tute et jucunde*), and this has led to a recognition of the typical formula as consisting of four ingredients, each related to this object and named accordingly.

1st ingredient—Basis or base.	Cure.
2d ingredient—Adjuvant or auxiliary.	Quickly.
3d ingredient—Corrigent or corrective.	Safely.
4th ingredient—Excipient or vehicle.	Pleasantly.

While these terms aid us in comprehending the full purpose of prescription writing, it must be understood that a formula need not contain more than one active agent, and that any combination of medicines should always be based upon definite objects to be attained, either as to form or utility.

Several definitions are here necessary to the proper understanding of terms:

A **formula** consists of the names and quantities of ingredients that are to enter into a medicinal preparation, with directions for compounding them.

An *official* formula is one that is contained in the *United States Pharmacopœia*.

An *extemporaneous* formula is one that is made up by the prescriber for the occasion.

A formula may be *simple*, containing only one medicinal agent, or *compound*, containing two or more active ingredients.

A **prescription** consists of the formula for the preparation of a medicine, to which is added the directions for its use in a given case.

Whenever a prescription orders an *official formula*, only the title of the latter need be given, without naming the ingredients. Thus, Dover's powder (containing opium 1 part, ipecacuanha 1 part, and sugar of milk 8 parts) is official under the title Pulvis Ipecacuanhæ et Opii. In prescribing, therefore, it is only necessary to write—

℞.—Pulveris Ipecacuanhæ et Opii (quantity),

instead of naming each ingredient and its quantity, as would be necessary if it were not official.

A **pharmacopœia** is a book of national authority, containing a list of recognized drugs and preparations, with their descriptions, tests and formulas. It is the authoritative standard for the purity and strength of drugs and for uniformity of preparations. It may give the average dose of each internal remedy, but it includes nothing of the actions and uses of drugs. While in most countries the pharmacopœias are under governmental control, the *United States Pharmacopœia* is under the control of the professions of medicine and pharmacy, and is revised by their direction every ten years.

The points involved in making a compound prescription are:

(*a*) Selection of the drugs to be employed.

(*b*) Their solubility (unless powder form is desired).

(*c*) Their compatibility in the desired combination.

(*d*) Their dose.

These points will be considered separately.

SELECTION OF INGREDIENTS.

Selection of drugs must depend *primarily* upon a knowledge of the conditions to be treated and acquaintance with the power of drugs to remedy the same, and *secondarily* upon the practicability of their administration or their combination with other necessary ingredients. Some drugs, by reason of their chemical properties, must always be given alone; others cannot be brought into solution; others are poisonous.

Under this heading the main objects of combining medicines may be stated as follows:

1. To secure the *combined effects* of similarly acting medicines—*e. g.*, strychnine, as a bitter tonic, may be combined with iron as a general restorative tonic.
2. To secure the effects of medicines that have *distinct* and *unrelated* actions—*e. g.*, in the official Pilulæ aloes et ferri, the aloes is a cathartic and the iron a restorative to the blood.
3. To secure the *opposite effects* of medicines.
   (*a*) *By correcting or modifying the action of the base,* as when tincture of aconite is added to tincture of iodine to render its action milder.
   (*b*) *By rendering the action of the base safer.* Here antagonism of drug actions is made use of, as in the common addition of atropine to morphine in order to counteract its depressant action upon the respiratory center.

4. To secure a *suitable form.*
   (*a*) *By the use of special solvents* to obtain a liquid form of an otherwise insoluble substance—*e. g.*, salicylic acid requires 460 parts of water to dissolve it, but if borax is first dissolved to saturation salicylic acid is soluble in less than 100 parts of the solution.
   (*b*) *By securing a finely divided state of the drug.* Sugar of milk is often used, on account of the hardness of its crystals, to rub up other drugs into very fine particles, as in tablet triturates.
   (*c*) *By obtaining a mixture that is agreeable to the sight and pleasant to the taste.*
5. To obtain a combination to act as a *new substance.*
   (*a*) *By simple mixture.* Dover's powder contains opium and ipecacuanha, the combination having a diaphoretic effect not possessed to any degree by the separate drugs.
   (*b*) *By chemical action.* Chemicals are sometimes combined in order to obtain a new definite compound by their reaction.
6. For *preservation of the medicine.*
   Alcohol, glycerin, or sugar in large quantity, may serve not only as excipients, but also to preserve medicinal preparations which are to be kept for some time. It is not considered good pharmacy to add antiseptics to medicines.

Sugar in dilute solution will ferment easily at a summer temperature, but when used in strong solution (70 to 85 per cent.), as in some of the official syrups, it will preserve the preparation indefinitely.

Knowing what substances we wish to combine, the form of the combination must be determined, whether powder, pill, capsule, or liquid. For the first three the quality of solubility is unimportant, but when the medicine is to be in liquid form, solution must be secured whenever it is possible.

SOLUBILITY.

The prescriber should familiarize himself with the solubility of each of the solid substances that he is likely to use, for the reason that no rule of solubility can be laid down. A few general statements, however, may serve some purpose.

It is found that *salts* are usually *more soluble in water* than in alcohol. Substances that are soluble in water are quite likely to be soluble in glycerin.

Gums and *mucilages* are *soluble in water*, but insoluble in alcohol.

Resins and *resinous substances* are *soluble in alcohol*, but insoluble in water.

Substances that are soluble in alcohol are generally soluble also in ether, chloroform and benzin.

Water stands as the most universal solvent and vehicle in medicinal combinations.

Alcohol is most valuable in preparations that are to be kept, because of its preservative power in addition to being an excellent solvent.

Glycerin has solvent powers similar to those of water, and it is also a good preservative.

With some drugs it is necessary to add an *acid*, and with others an *alkali*, to aid solution—*e. g.*, borax will aid solubility in water of both benzoic and salicylic acids; on the other hand, quinine sulphate has its solubility in water increased by the addition of sulphuric acid.

A number of substances can be conveniently handled in saturated solution, some to be used in full strength, others requiring dilution. The following table furnishes the degree of solubility, and also the *approximate* percentage strength of saturated aqueous solutions, of a number of the most commonly used substances: [For solubility of other agents, see Index of Drugs.]

	Soluble in parts of water.	Percentage strength of saturated solution.
Acid, benzoic	275	0.36 per cent.
Acid, boric	18	5.5 "
Acid, carbolic (phenol)	15 to 20	5 "
Acid, salicylic	460	0.22 "
Acid, tannic	0.34*	300 "
Alum	9	11 "
Ammonium carbonate	4	25 "
Ammonium chloride	2.6	40 "
Antipyrine	1	100 "
Betanaphtol	1000	0.1 "
Caffeine, citrated	4†	25 "
	25	4 "
Caffeine sodiobenzoate	1.1	90 "
Calcium chloride	1.2	83 "
Chloroform	200	0.5 "
Cocaine hydrochloride	0.4	250 "
Codeine phosphate	2.3	45 "
Copper sulphate	2.5	40 "
Corrosive sublimate	13.5	7.4 "
Creosote	140	0.71 "
Iodine	3000‡	

* U. S. P., 1900.

† Citrated caffeine with about 4 parts of hot water forms a clear, syrupy solution which, when diluted, deposits caffeine, which redissolves with 25 parts of water.

‡ The solubility of iodine is increased by the addition of potassium iodide, as in Lugol's solution and in the tincture.

	Soluble in parts of water.	Percentage strength of saturated solution.
Lead acetate	1.4	70 per cent.
Magnesium oxide	15*	7 "
Magnesium sulphate	1	100 "
Morphine sulphate	15.5	6.5 "
Potassium bicarbonate	3	33 "
Potassium bitartrate	155	0.65 "
Potassium bromide	1.5	66 "
Potassium carbonate	0.9	110 "
Potassium chlorate	11.5	8.7 "
Potassium iodide	0.7	143 "
Potassium nitrate	2.8	36 "
Potassium permanganate	13.5	7.4 "
Potassium sulphate	9	11 "
Quinine bisulphate	9	11 "
Quinine sulphate	725	0.14 "
Resorcinol	0.9	110 "
Saccharine (benzosulphinide)	290	0.35 "
Silver nitrate	0.4	250 "
Sodium benzoate	1.8	55 "
Sodium bicarbonate	10	10 "
Sodium borate	15	6.6 "
Sodium bromide	1.1	90 "
Sodium chloride	2.8	36 "
Sodium thiosulphate (hyposulphite)	0.5	200 "
Sodium salicylate	0.9	110 "
Strychnine sulphate	32	3.1 "
Sugar	0.5	200 "
Thymol	1000	0.1 "
Zinc acetate	2.3	43 "
Zinc chloride	0.25	400 "
Zinc sulphate	0.6	166 "

The following table is of convenience in preparing any solution of a desired percentage strength. Quantities are expressed in the old system of measures, with metric equivalents also given. The result is not absolutely exact, but sufficiently so for practical purposes:

Amount of solution wanted.	Quantity of drug needed for				
	$\frac{1}{2}$% strength.	1% strength.	2% strength.	5% strength.	10% strength.
1 fluidrachm (4 c.c.).	$\frac{3}{10}$ grain (0.02 gm.).	$\frac{3}{5}$ grain (0.04 gm.).	$1\frac{1}{5}$ grains (0.08 gm.).	3 grains (0.20 gm.).	6 grains (0.40 gm.).
1 fluidounce (30 c.c.).	$2\frac{1}{2}$ grains (0.15 gm.)	5 grains (0.30 gm.).	10 grains (0.60 gm.).	24 grains (1.50 gm.).	48 grains (3 gm.).
1 pint (500 c.c.).	40 grains (2.5 gm.).	80 grains (5 gm.).	$2\frac{1}{2}$ drachms (10 gm.).	$6\frac{1}{4}$ drachms (25 gm.).	$12\frac{1}{2}$ drachms (50 gm.).

* With 15 parts water magnesia does not dissolve, but forms the gelatinous milk of magnesia.

To illustrate: suppose a fluidounce (30 c.c.) of a 2 per cent. solution of cocaine hydrochloride is wanted. Opposite the desired quantity in the first column find the quantity expressed in the 2 per cent. column, which in this case is 10 grains (0.60 gm.). This dissolved in the fluidounce of water will make the desired strength of solution.

INCOMPATIBILITY.

Unless the ingredients of a prescription are compatible with each other the object of their combination may be lost, for a reaction may occur between two drugs, with the result that the activity of each is altered or destroyed. Again, such reaction may, in case of certain substances, produce poisonous compounds.

Incompatibility may be *physical* or *chemical.*

Physical Incompatibility consists of (*a*) alterations in conditions of solubility without any chemical change, and also (*b*) pertains to the inability of certain substances to mix with each other, as oil and water.

Examples of physical incompatibility are:

1. Gums and mucilaginous substances are precipitated from aqueous solutions by alcohol and alcoholic liquids—*e. g.*, syrup of acacia with tincture of chloride of iron will precipitate the acacia.

2. Resinous substances are precipitated from alcoholic solutions by water—*e. g.*, tincture of myrrh with water will become turbid from precipitation of resin.

Chemical Incompatibility consists in chemical reactions between substances, whereby their nature is altered. There may be:

1. Simple chemical change without any visible result.
2. Simple chemical change with or without loss of medicinal activity.
3. Precipitation of a new compound that is insoluble.
4. Coagulation.
5. Formation of poisonous compounds.
6. Formation of explosive compounds.

It is difficult to bring all instances of chemical incompatibility under rule; and the knowledge of chemistry necessary to predict always that incompatibility will or will not occur, is not a common possession. In addition to the more important incompatibilities previously given in connection with the individual drugs, there are given below some general statements that will serve as a basis for study. A cardinal rule to be observed is that *drugs should never be prescribed with their chemical tests,* unless a chemical reaction is desired.

1. Alkalies, hydrates and carbonates react with acids and acid salts.

2. Alkalies, hydrates and alkaline carbonates react with salts of alkaloids. If the latter are in solution, precipitation of the pure alkaloids occurs.

3. Solutions of tannic acid react with salts of copper, iron, lead and mercury.

4. Solutions of tannic acid react with alkaloids and with their salts.

5. Acids or acid salts react with alkalies, hydrates, carbonates and with salts of glucosides.

Other common incompatibilities that do not admit of classification include:

The reaction of certain salts with each other—*e. g.*, nitrate of silver with any chloride.

Alcohol and chloral hydrate.

Antipyrine and spirit of nitrous ether (when acid).

Borax and solution of corrosive sublimate.

Carbolic acid (pure or saturated aqueous solution) and cocaine hydrochloride.

Carbolic acid (pure or sat. aq. soln.) and antipyrine.

Carbolic acid and collodion.

Glycerin with potassium chlorate and tincture of chloride of iron.

Iodine (in solution) and starch.

Lime-water with calomel or corrosive sublimate.

Potassium iodide and spirit of nitrous ether (if acid).

Potassium permanganate and sulphur (explode when triturated).

Potassium permanganate and glycerin, syrup or other liquids containing organic matter.

Powerful chemical drugs and oxidizing and reducing agents should be prescribed alone. It would be well to avoid combining the following with other substances:

Acids, strong.
Alkalies and their hydrates.
Arsenic.
Mercuric chloride.
Potassium chlorate.
Potassium permanganate.
Silver nitrate.
Tannic acid.

It should be noted that chemical incompatibility may be intentional, in order to obtain a new substance—*e. g.*, in preparing ferri hydroxidum, magnesium oxide (alkaline) and solution of a ferric salt (acid) are mixed, the result being a precipitate of the hydroxide. Also, in the employment of chemical antidotes in the treatment of poisoning, their value is based upon their incompatibility with the poison.

ANTAGONISM OF DRUGS.

The term *therapeutic incompatibility* does not apply to the combination of drugs, but to their action. It is often used to designate what is better known as *antagonism of drugs.*

We recognize and employ the opposite effects of drugs to the extent of combining them in order to guard against poisoning, and of administering, in case of poisoning, a drug that shall counteract or antagonize the toxic action. In this sense we speak of such drug as a *physiologic antidote* to the poison. But while we thus employ antagonism of drugs to good purposes, in our prescriptions we avoid combinations that will neutralize the desired effect of the principal drug or drugs, unless a corrective action is needed, as when belladonna or a volatile oil is added to a strong cathartic drug to prevent griping.

Antagonism of drugs can seldom be absolute—*i. e.*, there are very few drugs whose effects exactly neutralize the effects of other drugs. In cocaine poisoning we find that two drugs, at least, are needed to fully cover the depressant action of the poison. (Plate IV.) Antagonism, therefore, is usually only partial, but it still may meet the most serious symptom in a case. Thus in poisoning by morphine the most dangerous condition is that of paralysis of the respiratory center. Strychnine will antagonize this condition, though it has almost no influence upon the narcosis.

Among the medicines discussed in this treatise the most positive antagonistic relations are the following:

Drug.	Antagonist.	Site of antagonism.
Aconite	Atropine . . .	Vagus nerve.
	Nitrites . . .	Vagus nerve.
	Caffeine . . .	Heart.
	Digitalis . . .	Heart.
Atropine	Aconite . . .	Vagus nerve.
	Digitalis . . .	Vagus nerve.
	Morphine . .	Respiratory center, cerebrum.
Bromides, Chloral	Caffeine . . .	Brain, circulation.
	Atropine . .	Brain, circulation.
	Digitalis . . .	Heart.
	Strychnine . .	Medulla, spinal cord.

Drug.	Antagonist.	Site of antagonism.
Caffeine	Aconite	Heart.
	Bromides, chloral	Brain, heart.
	Morphine	Brain, respiratory center.
	Anesthetics	Brain, respiratory center, heart.
Chloroform	Caffeine	Cerebrum, respiratory center, heart.
	Strychnine	Heart, respiratory center, spinal cord.
	Digitalis	Heart, vasomotor system.
Cocaine	Atropine	Cerebrum, respiratory center, heart.
	Caffeine	Cerebrum, respiratory center, heart.
	Strychnine	Respiratory center, heart, spinal cord.
	Digitalis	Heart.
Digitalis	Aconite	Heart.
	Atropine	Vagus nerve.
	Bromides, chloral	Heart.
	Chloroform	Heart, vasomotor system.
	Cocaine	Heart.
	Nitrites	Vagus center, vasomotor system.
Ether	Caffeine	Cerebrum, respiratory center.
	Strychnine	Respiratory center, spinal cord.
Morphine	Atropine	Cerebrum, respiratory center.
	Caffeine	Cerebrum, respiratory center.
	Strychnine	Respiratory center, other reflex centers.
Nitrites	Aconite	Vagus nerve.
	Atropine	Vasomotor system.
	Caffeine	Vasomotor system.
	Digitalis	Vagus center, vasomotor system.
	Ergot	Vasomotor system.
	Strychnine	Vasomotor system.
Strychnine	Bromides, chloral	Medulla, spinal cord.
	Chloroform	Heart, respiratory center, spinal cord.
	Ether	Respiratory center, spinal cord.
	Morphine	Respiratory center, other reflex centers.
	Nitrites	Vasomotor system.

Antagonism of local remedies depends chiefly upon their chemical qualities, the action being usually an antidotal one, as when an acid is neutralized by an alkali, or silver nitrate by sodium chloride. This part of the subject is treated whenever necessary in connection with the various local remedies. (For chemical antidotes, see Table of Poisons and Antidotes.)

DOSES.

Posology, or the science of dosage, constitutes an important part of our knowledge of drugs. Whether we use few or many substances, safety requires us to know concerning each, what quantity may be expected to produce a certain desired effect and also what quantity must not be exceeded when it is necessary to secure its full physiologic influence. Conditions in disease vary so greatly, and the individual susceptibilities of patients are so uncertain, that we must regard the statement of a single definite quantity for a dose as being somewhat arbitrary. Therefore, it is advisable to know, not a single quantity, but a range which

shall include the minimum and the maximum of ordinary dosage. Idiosyncrasy forbids the use of certain drugs with certain individuals. It also modifies the action of the drug in some cases. Tolerance for certain drugs, particularly morphine, may be established, so that those who take it habitually frequently come to use doses many times greater than the ordinary poisonous dose. The mode of administration, whether by stomach or hypodermically, will modify dosage. (See chapter on Administration of Medicines.) After all, the dose of a drug is a relative quantity, which requires to be varied, according to conditions, within a certain range of efficiency and safety. The doses of the principal drugs, or of one or two preparations of each, which represent them fully, should be learned.

Dosage for Children.—The doses usually given in text-books and tables are for adults. For children only a fractional quantity, proportional to the age, may be used. The simplest rule for the calculation of a child's dose is that known as *Cowling's Rule,* which is: *Divide the age of the child at its next birthday by* 24. Thus a child three years old will have $\frac{4}{24}$ or $\frac{1}{6}$ of the adult dose. Young's rule, *which divides the child's age by the age* + 12, gives a slightly larger fraction; thus $\frac{3}{3+12}=\frac{1}{5}$. In connection with such rules it must be borne in mind that children are very susceptible to the action of opium and morphine; therefore, these drugs, always to be avoided with children if possible, may only be given in much smaller quantity than the proportional dose by rule.

THE PRESCRIPTION.

A proper prescription always consists of five parts:

1. The heading.
2. Names and quantities of ingredients.
3. Directions to the compounder.
4. Directions to the patient.
5. Date and signature.

These will be considered in order:

1. **The Heading.**—Anciently the prescription was begun with a prayer to Jupiter or other heathen deity. Later this was shortened to the simple sign of Jupiter (♃). With an upright stroke before it we have a resemblance to the sign ℞, which we use today. To us this sign really means: "Take," being an abbreviation of the imperative form *recipe* of the Latin verb *recipio*—to take.

2. **Names and Quantities of Ingredients.**—The *names* are usually written in Latin, for the reasons that this is not subject to the changes of a modern language and, being a universal language of science, it is known the world over. A formula in Latin, therefore, can be read anywhere in the world of science today, and doubtless will be just as current one hundred years hence as now.

The *quantities* are expressed either in the terms of apothecaries' weight and corresponding liquid measure, or in terms of the metric system. The latter has the advantage of simplicity in being a decimal system. Calculation by it is easier, and there is less danger of error, because the position of a figure denotes its value, and not an added sign that may be poorly written.

3. **Directions to the Compounder.**—In most cases the precise mode or detail of compounding is better left to the dispenser, who is trained in that art, and the simple abbreviation M., which stands for the Latin imperative *misce*, meaning "mix," is sufficient. Only when the prescriber has special directions to give, or when directing the number of pills or powders into which a mixture is to be divided, need he write out his directions in full. In such case Latin may be used, but plain English is preferable, unless the prescription is likely to go to a foreign country.

4. **Directions to the Patient.**—This part added to a formula makes of it a prescription. It is begun with the abbreviation Sig. (or S.), which stands for the Latin *signa*, meaning "Write;" and whatever is directed should follow this sign and be written without abbreviation, so that it may be copied *verbatim* upon the label. Not only should these directions be written out in full, but they should be read to the patient or attendant, in order to guard against danger through a possible error in copying. The directions to the patient must state how the medicine is to be used—if locally, the word "apply" may be included; there is good reason also for placing immediately after the "Sig." the term "mouth-wash," "gargle," "ointment," "wash," or whatever will best designate the nature of the local application and serve to guard against its being taken internally; if internally, the directions must include *dose* in drops, teaspoonfuls, etc., and the *time* or *intervals* of taking. This part of the prescription must be very explicit, and the common phrase "use as directed," with only verbal directions to the patient, should be discarded.

In case a poisonous application is ordered it is well to add the word "Poison" to the directions, with, however, verbal explanation to the patient or attendant as to its proper use.

5. **Date and Signature.**—The date is essential for reference, and the prescriber's signature for authenticity. It is common practice, however, to use printed forms which have the prescriber's name and address above or below the blank space reserved for the prescription proper, in which case the signature is often omitted.

The name or initials of the patient should be added, in order to avoid the use of the wrong medicine, in case of more than one prescription being filled at the same time for different members of a family.

Sometimes a special note in addition to all the above will be advisable, as when quite large doses of a drug are ordered; the statement "large dose intended," or *writing out* the quantity, will show the dispenser that the amount ordered is correct.

Again, the evil of repeating prescriptions by unprofessional pharmacists may be guarded against by writing prominently upon the prescription the words "not to be repeated."

The reference above to improper pharmacy leads the author to express his appreciation of the professional pharmacy which is so evident today. The knowledge of doses that the pharmacist is required to possess is a safeguard against errors of dosage in prescriptions. The prescriber is responsible for whatever he writes, but physicians have often been saved the humiliation of discovered error in prescribing, or the results that might follow, by the coöperation of the pharmacist in calling attention confidentially to the same—a kind of favor too often unappreciated by the prescriber.

THE USE OF LATIN IN PRESCRIPTIONS.

To write prescriptions in best form requires some knowledge of Latin, especially of the declensions of nouns and adjectives, but not more than can be acquired in a very short time with the aid of a Latin grammar. To one not sufficiently familiar with the language, this course is earnestly advised, as repaying well the effort that is necessary.* As a means of review, and in order to emphasize what is really essential to our purpose, a brief outline of the essential grammatic forms is here given, without any attempt at completeness. Many case-endings are never used in prescriptions, and are, therefore, omitted. The genitive endings are given prominence because they are almost invariably employed.

* A very useful aid is the Latin Grammar of Pharmacy and Medicine, Robinson. P. Blakiston's Son & Co., Philadelphia.

Declensions of Nouns and Adjectives.

Nouns.	1st Declension. Fem.	2d Declension. Masc.	2d Declension. Neut.	3d Declension. Masc. and Fem.	3d Declension. Neut.	4th Declension. Masc. and Fem.	4th Declension. Neut.
Singular.							
Nominative	a (e)	us (os)	um (on)	(various)		us	u
Genitive	**ae (es)**	**i**		**is**		**us**	**u**
Accusative	am (en)	um (on)		em	(as Nom.)	The 4th declension includes only four names of drugs: Cornus, Fructus, Quercus, Spiritus	
Ablative	a (e)	o		e			
Plural.							
Nominative	ae	i	a	es	a		
Genitive	**arum**	**orum**		**um (ium)**			
Accusative	as	os	a	es	a		
Exceptions:	Theobroma—*tis*, and Physostigma—*tis*, are of the 3d declension.	Rhus—*ois*, is of the 3d declension.					

Indeclinable:	Amyl Buchu Catechu Elixir	Gambir Kino Sassafras	Alcohol Eucalyptol Menthol	are regarded by some authorities as indeclinable.

Adjectives.	1st and 2d Declension. Fem.	1st and 2d Declension. Masc.	1st and 2d Declension. Neut.	3d Declension. Masc. and Fem.	3d Declension. Neut.	
Singular:						
Nominative	a	us (er)	um	is (s)	e (s)	Adjectives of other terminations and plural forms are very seldom used in prescriptions.
Genitive	**ae**	**i**	**i**	**is**		
Accusative	am	um	um	em	e (s)	

The rules of Latin grammar apply as to relation of nouns, adjectives, verbs and other parts of speech.

Use of Cases.—The nominative case is never used in a prescription, as the sentence is always introduced by the imperative *recipe*, the subject of which is *thou* understood. The complete sentence would be:

Take thou	of a substance (genitive)	a quantity. (accusative)

The genitive case of the name of ingredient is required when the *quantity* is expressed by a noun, as:

Take thou	of a substance (genitive)	one ounce. (accusative)

The accusative case of the name of the ingredient is required when the *quantity* is expressed by a simple numeral adjective, as:

Take thou *four* pills = ℞. Pilulas iv.

The ablative case is used after the preposition *cum* (meaning *with*), as:

℞.—Ferri hydroxidi *cum* magnesii oxido, ℥j.

Verbs.—The few verbs employed are in the imperative form except where the directions to the compounder are written in Latin, when the passive form may be also needed, as:

℞.—Massæ hydrargyri, gr xxx.
Fiant pilulæ, vj. (*Let be made* pills six.)

WEIGHTS AND MEASURES.

The system of weights and measures most approved in scientific circles is the *metric system*. Being a decimal system, it is easily mastered, and no student in any department of medical science should be excused from acquiring a practical familiarity with its use. The *United States Pharmacopœia* employs it exclusively in the expression of quantities of ingredients.

While it is not possible to discard the *apothecaries' system* entirely at the present time, because of the large number of practitioners who have used it for years, whenever the old system is employed its denominations may be reduced to three, as follows:

Apothecaries'.	*Liquids.*
60 grains (gr.) = 1 drachm (ʒ)	60 minims (♏) = 1 fluidrachm (fʒ)
8 drachms = 1 ounce (℥)	8 fluidrachms = 1 fluidounce (f℥)

The use of the scruple ℈ (20 gr.) often leads to a confusion of signs, and the pound (16 oz.) is seldom required in prescribing, so they are omitted.

The Metric System.—In studying the metric system advantage may be taken of its similiarity to our American system of money, using the latter to illustrate the former in a very simple way, as appears below. In the comparison below, the decimal point, or perpendicular line, is the dividing point between units and fractions:

	$	Dimes.	Cents.	Mills.
United States money	10	0	0	0

NOTE.—In practical use we disregard the term *decigram*, much as we do the term *dime*, using *centigrams*, as we do *cents*, for any fraction of the unit; but the term *milligram* is much used because of the small fractions which so many doses require.

Metric weight	Grams	Decigrams.	Centigrams.	Milligrams.			Approximately.
	10	0	0	0			
	1				=	15.4 grains.	15 grains.
		1			=	1.5 "	1½ "
		0	1		=	0.15 "	$\frac{1}{6}$ "
		0	0	1	=	0.015 "	$\frac{1}{60}$ "

Metric capacity **Milliliter** or **Cu. centimeter**						Approximately.
1				=	16.23 minims.	16 minims.
	1			=	1.6 "	1½ "
	0	1		=	0.16 "	$\frac{1}{6}$ "
	0	0	1	=	0.016 "	$\frac{1}{60}$ "

Equivalents of apothecaries' weights and liquid measures in grams and cubic centimeters are:

		EXACTLY. *Gm.*	APPROXIMATELY. *Gm.*
$\frac{1}{100}$ grain	=	.000648	.0006
$\frac{1}{60}$ "	=	.00108	.001
$\frac{1}{10}$ "	=	.00648	.006
$\frac{1}{8}$ "	=	.0081	.008
$\frac{1}{4}$ "	=	.0162	.015
$\frac{1}{2}$ "	=	.0324	.03
1 Grain	=	.0648	.06 or .065
3 grains	=	.1944	.20
4 "	=	.2592	.25
5 "	=	.3239	.30

		EXACTLY. *Gm.*	APPROXIMATELY. *Gm.*
10 grains	=	.6479	.60 or .65
15 "	=	.9717	1.
15.43 "	=	**1.**	**1.**
20 "	=	1.296	1.30
30 "	=	1.944	2.
1 Drachm	=	3.888	4.
2 drachms	=	7.776	8.
4 "	=	15.551	15.50
1 Ounce	=	31.102	31.

		EXACTLY.	APPROXIMATELY.
		C.c.	*C.c.*
1 Minim	=	.06161	.06
4 Minims	=	.24644	.25
5 Minims	=	.30805	.30
10 Minims	=	.6161	.60
15 Minims	=	.924	1.
16.23 Minims	=	1.	1.

		EXACTLY.	APPROXIMATELY.
		C.c.	*C.c.*
1 Fluidrachm	=	3.696	3.7
1 Fluidounce	=	29.573	30.
1 Pint	=	473.179	475.*
1 Quart	=	946.358	950.*
1 Gallon	=	3785.432	3800.

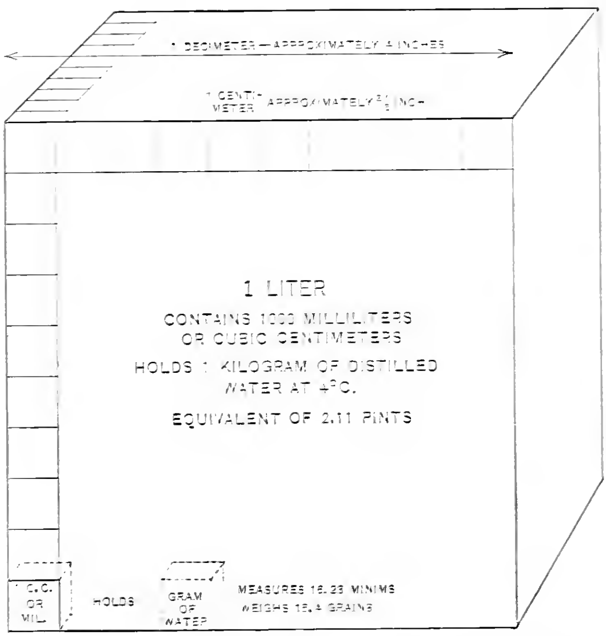


FIG. 15.—Diagram showing: 1. The capacity of 1 liter with its equivalents. 2. Linear measures—decimeter and centimeter, with equivalents. 3. The cubic centimeter or milliliter, and gram, with equivalents. (Slightly reduced in size.)

The several units of the metric system are:

Unit of length: Meter = One forty-millionth part of the earth's meridian (39.37 inches).

Unit of capacity: Liter = One cubic decimeter (1.05 quarts).

Unit of weight: Gram = Weight of one *Cubic centimeter* or *Milliliter* of distilled water at 4° C., the point of greatest density of water (15.4 grains).

Following are given the exact and approximate equivalents of the metric measures of length, capacity and weight.

* For ordinary purposes 500 c.c. is the convenient approximate equivalent of a pint and 1000 c.c. of a quart.

LENGTH.

EXACT EQUIVALENTS.			APPROXIMATE EQUIVALENTS.
.03937079 inch	Millimeter,	.001	1/25 of an inch.
.3937079 inch	Centimeter,	.01	2/5 of an inch.
3.937079 inches	Decimeter,	.1	4 inches.
39.37079 inches	**Meter,**	1.	3 feet 3 inches.
32 feet 9.7079 inches	Dekameter,	10.	2 rods.
328 feet 1.079 inches	Hektometer,	100.	20 rods.
3280 feet 10.79 inches	Kilometer,	1000.	5/8 of a mile.
6.213824 miles	Myriameter,	10000.	6 1/5 miles.

CAPACITY.

EXACT EQUIVALENTS.				APPROXIMATE EQUIVALENTS.	
Liquid.	*Dry.*			*Liquid.*	*Dry.*
.2705624 fʒ	.06102705 cu. in.	Milliliter,	.001	16 *m*	.06 cu. in.
.338158 f℥	.6102705 cu. in.	Centiliter,	.01	2.7 fʒ	.6 cu. in.
.845395 gi.	6.102705 cu. in.	Deciliter,	.1	3.3 f℥	6 cu. in.
1.0567454 qts.	.90813 qt.	**Liter,**	1.	1 qt.	.9 qt.
2.64186 gal.	1.13516 pks.	Dekaliter,	10.	2.5 gal.	1 pk.
26.4186 gal.	2.8379 bu.	Hektoliter,	100.	26 gal.	2.8 bu.
264.186 gal.	1.30802 cu. yds.	Kiloliter,	1000.	8.3 bbls.	35 cu. ft.
2641.86 gal.	13.0802 cu. yds.	Myrialiter,	10000.	84 bbls.	13 cu. yds.

WEIGHT.

EXACT EQUIVALENTS.				APPROXIMATE EQUIVALENTS.	
Avoirdupois.	*Troy.*			*Avoirdupois.*	*Troy.*
	.01543234874 grain	Milligram,	.001		1/60 grain.
	.1543234874 grain	Centigram,	.01		1/6 grain.
	1.543234874 grains	Decigram,	.1		1.5 grains.
	15.43234874 grains	**Gram,**	1.		15 grains.
5.6438304 drs.	2.572 ʒ	Dekagram,	10.	5.6 drs.	2.5 ʒ
3.5274 oz.	3.215 ℥	Hektogram,	100.	3.5 oz.	3 ℥
2.2046 lbs.	2.679 lbs.	Kilogram,	1000.	2.2 lbs.	2.6 lbs.
22.046 lbs.	26.79 lbs.	Myriagram,	10000.	22 lbs.	26 lbs.

Metric equivalents of our common linear measures are:

		Meters.		EXACTLY.	APPROXIMATELY.
1/4 Inch	=	.00635	or	6.35 Millimeters.	6 1/4 Millimeters.
3/4 Inch	=	.01905	"	19.05 "	19 "
1 Inch	=	.0254	"	**2.54 Centimeters**	2 1/2 Centimeters.
6 Inches	=	.1524	"	15.24 "	15 "
10 Inches	=	.2540	"	25.40 "	25 "
1 Foot	=	.3048	"	**30.48 Centimeters**	30 1/2 "
1 Yard	=	.91439	"	91.439 "	90 "
1 Rod	=	5.02914	"	5.02914 Meters.	5 Meters.
1 Mile	=	1609.3264	"	1.6093264 Kilometers.	1.6 Kilometers.

While the *gram* is a measure of weight and the *milliliter* of capacity, liquids may be weighed and expressed in grams. But the *U. S. P.* weighs solids and measures liquids in its formulas. To avoid confusion in prescribing, we specify both grams and milliliters in our prescription forms:

Gm. or mil.

℞

Thus whole numbers (to left of line) will be read as grams if they represent solids and as milliliters if liquids, while decimal quantities will be read as centigrams and milligrams in either case, as the difference between the measure and weight of so small quantities is very slight.

Rules for Converting Quantities to Metric Terms:

1. If in grains (or minims), multiply the number by 0.065 (fluids 0.06) or divide by 15 (fluids 16). The result will express the quantity in grams or decimal of a gram.

2. If in drachms, multiply the number by 4 (fluids 3.70). The product will express the quantity in grams.

3. If in ounces, multiply the number by 31 (fluids 30). The product will express the quantity in grams.

Rules for Converting Quantities from Metric Terms:

1. Divide grams by 0.065 (fluids 0.06) or multiply by 15 (fluids 16). The result will be in grains (or minims).

2. Divide grams by 4 (fluids 3.70). The result will be in drachms.

3. Divide grams by 31 (fluids 30). The result will be in ounces.

In learning doses in metric terms, it is well to begin with *convenient* quantities that approximate the usual dose; thus:

For substances with a minimum dose of $\frac{1}{60}$ of a grain, adopt 0.001 gm. (1 milligram) as the convenient basis.

For substances with a minimum dose of 1 grain, adopt 0.05 gm. (5 centigrams) as the starting-point.

For substances having the minimum dose of 10 grains, adopt 50 gm. (50 centigrams) as the starting point.

For larger doses adopt grams and half-grams as nearly as possible.

Rules for Use of the Metric System in Prescribing:

The difficulty of applying the metric system to prescription writing by those accustomed to think in the old system is very largely removed by following the rule given below, which does away with the need of calculating total quantities, and renders prescribing much easier.

As there are between fifteen and sixteen grains in a gram, the ordering of fifteen or sixteen doses always establishes a relation between the two systems, which permits us to apply the following rule.*

* Long. Medical News, Philadelphia, March 25, 1893.

1. Make the whole quantity to consist of sixteen doses: then—

2. The number that represents the single dose of an ingredient in grains or minims will express the required quantity of that ingredient in grams or milliliters. For example:

	Gm. or mil.	
℞.—Potassii bromidi (single dose 10 grains) . . .	10	
Morphinæ sulphatis (single dose $\frac{1}{4}$ grain) . .		25
Spiritus ætheris nitrosi (single dose 30 minims)	30	
Aquæ, q. s. ad (16 teaspoonful doses) . . .	60	
M.—Sig., etc.		

The same rule applies in prescribing powders or pills:

	Gm. or mil.	
℞.—Pulveris ipecacuanhæ et opii (single dose 5 grains)	5	
Pulveris digitalis (single dose 1 grain) . . .	1	
Strychninæ sulphatis (single dose $\frac{1}{50}$ grain) . .		02
Misce et divide in chartulas numero xvi.		

It is found in practice that sixteen is a very convenient and usually sufficient number of doses in the average case, or until the treatment is to be modified. However, when one has mastered the application of the rule, it is a simple matter to double the quantities for twice the number or doses, or to reduce them for a lesser number.

While this rule does not apply in making solutions without definite dosage, the convenience of the decimal system in ordering and preparing percentage solutions is apparent. With a total quantity of 1000, 100, or 10 mils. the calculation of quantity of ingredients is very simple.

COMMON MEASURES AND THEIR EQUIVALENTS.

In the fourth part of a prescription (directions to the patient), the amount to be taken should be expressed in domestic measures as far as is possible, so as to be perfectly plain to the user. The use of the measuring glass, marked for quantities to correspond to the common measures of teaspoon, tablespoon, etc., should be encouraged in the interest of accuracy; for there is some variation in size of teaspoons as there are grades of fulness to the spoon, one person making it even full and another filling it to its capacity, which may mean a difference of fully thirty minims.

The common practice of ordering doses in so many drops is likewise inaccurate unless one is sure of the size of the drop of the particular liquid as administered; for there is a great difference in the size of drops, dependent not only upon the density and character of the liquid but also upon the shape of the opening from which it is dropped. For example, in dropping water from the mouth of an ordinary medicine bottle each drop may contain $1\frac{1}{2}$ minims, while from an eye dropper the drops may

not measure more than $\frac{1}{2}$ minim, varying according to size of opening and thickness of the glass. Drops of alcohol are approximately one-half the size of drops of water under like conditions, while drops of ether and chloroform are still smaller. (See below.)

It should be borne in mind, therefore, that although drops of aqueous solutions approximate minims in size, drops of alcoholic solutions, as tinctures, are about one-half as large and the number in a given dose will be correspondingly greater. But it is evident that the purpose of accurate dosage would be best served by the use of a pipette, marked for minims, in measuring out small doses.

Tables of the number of drops in a fluidrachm are of comparative rather than positive value, because of the difference in size of drops of the same liquid under different conditions. However, it is well to remember the following easily-learned facts in regard to the size of drops:

Water, aqueous solutions and *acids* have about 60 drops to a fluidrachm or teaspoonful.

Alcohol, tinctures and *spirits* have about 100 to 120 drops to a fluidrachm.

Ether and *chloroform* have still smaller drops, with from 120 to 250 to a fluidrachm.

The approximate equivalents of common measures are:

A drop (of water)	=♏ $\frac{1}{2}$–1,	or	0.03–0.06	gm.
A teaspoon	=f℥1,	or	4	mil.
A dessertspoon	=f℥2,	or	8	"
A tablespoon	=f℥4,	or	15	"
A wineglass	=f℥2,	or	60	"
A teacup	=f℥4,	or	120	"
A tumbler	=f℥7,	or	200	"

ORDER OF WRITING A PRESCRIPTION.

It is well to follow a regular order in writing prescriptions both in the interest of economy of time and thought and in order to lessen the danger of errors by omission. Certain parts of the work can be made quite mechanical including the use of a prepared form of blank something like the following:

A. L. Seek, M.D.
160 West 70th Street,
Hours: 2—4 New York.
Gm. or mil.

℞.—

If the old system of weights and measures is to be employed this blank will omit the upright line and the abbreviations above it.

The order usually followed in writing a prescription is as follows:

1. Decide what drugs are needed and select the preparation of each to be used; then write the names of all ingredients, as below.

Supposing our case to be a child of five with a cough that is spasmodic in character, we may wish to write:

℞.—Potassii bromidi,
Tincturæ belladonnæ,
Spiritus ætheris nitrosi,
Aquæ,
Syrupi lactucarii,

2. Decide upon the number of doses and bulk of each dose, by which you arrive at the total quantity of the mixture. For a child of five the single total dose may well be a teaspoonful and the number of doses 16, which gives a total quantity of 2 fluidounces or about 60 c.c.

3. Multiply the single dose of each ingredient by the number of doses.

Employing Cowling's rule for dosage for children: "*Divide the age at next birthday by* 24," we obtain $\frac{6}{24}$ or $\frac{1}{4}$ as the fraction of the adult dose to be used. But even with the use of the rule we must exercise discrimination. In this instance, potassium bromide being a rather harmless drug, we shall want a full dose in order to secure its depressant effect upon nerve centers, so we may exceed the proportional amount of the average adult dose. Let us take 6 grains (gm. 0.40) as the dose. Sixteen doses will give us 96 grains as the total quantity, or, approximately $1\frac{1}{2}$ drachms (gm. 6). Of tincture of belladonna we take according to the rule $\frac{1}{4}$ of the average adult dose, $\frac{1}{4}$ of 8 minims $\times 16$ doses $=32$ minims, or approximately $\frac{1}{2}$ fluidrachm (mils 2).

Of spirit of nitrous ether we take $\frac{1}{4}$ of 30 minims as the single dose or 8 minims (gm. 0.50). Sixteen times this will give us approximately 2 fluidrachms (mils 8). The two last ingredients are vehicles, water being used as a solvent and diluent and syrup of lactucarium as a pleasant excipient with very feeble medicinal power. The dose of these, therefore, is unimportant. Of water we use a convenient quantity to insure solution of the potassium salt, say $\frac{1}{2}$ fluidounce (mils 15). The vehicle last to be added may have its quantity definitely expressed, being the difference between the sum of other liquids in the mixture and the total desired bulk; but a simpler procedure is to order sufficient of the vehicle to be added to make up the total—*quantum sufficit* (q. s.) *ad* (up to) f℥ij (mils 60). We then have

				Gm. or mil.
℞.—Potassii bromidi		ʒiss	or	6
Tincturæ belladonnæ		fʒss	"	2
Spiritus ætheris nitrosi		fʒij	"	8
Aquæ		fʒiv	"	15
Syrupi lactucarii	q. s. ad	f℥ij	"	60

[In arriving at the above quantities in metric terms we may apply the simple rule for the use of the metric system (p. 279.)]

Whenever we order the same quantity of each of two ingredients, we may use the abbreviation āā, meaning *of each*. Had we made the quantity of water in the above the same as that of the spirit of nitrous ether we could have written them thus:

				Gm. or mil.
Spiritus ætheris nitrosi,				
Aquæ	āā	fʒij	or	8

4. The names and quantities of ingredients having been determined, the next step is to give the directions to the compounder (third part of prescription). In this case we need only to direct that the substances be mixed, leaving to the compounder's art the precise order or method to be followed. We, therefore, simply use the abbreviation of *Misce*,—M., which is placed either to the right on a line with the name of last ingredient or to the left on a line below.

5. Add directions to the patient (fourth part of prescription), to be preceded by the character Sig. or S. (see page 272).

6. The date name, or initials of patient and signature will complete the prescription (see page 273).

CONSTRUCTION OF PRESCRIPTIONS.

Dentifrices.—If we desire to write a prescription for a tooth powder, we consider first the essential qualities of the ingredients which should enter into it. Ordinarily we want a tooth powder to be:

1. Antacid.
2. Slightly abrasive (just sufficient to remove accumulation of deposits).
3. Aseptic or antiseptic.
4. Pleasant to the taste.

Occasionally also we desire it to be

Astringent or

Stimulating,

but these two qualities are needed in pathologic rather than normal conditions. The formula need not be complicated. Prepared chalk

and powdered soap will really cover all essentials, except that taste may be further consulted as to flavoring.

Written out in simple English, we may have a combination something like this, using our own preference for either the apothecaries' or the metric weights:

1.	Take		
	of prepared chalk,	ten ounces, or	310 grams.
2.	of powdered soap,	two ounces, or	62 grams.
	of oil of wintergreen,	five minims, or	0.30 grams.
3.	Mix and triturate thoroughly.		
4.	Write: Use with toothbrush each evening.		
5.	For A. B., Oct. 10, 1902.		(Chas. Dale).

But custom and certain advantages lead us to prefer the use of Latin terms and other characters as follows:

			Gm.	
℞.—Cretæ præparatæ	℥x	or	310	
Saponis pulv.	℥ij	or	62	
Olei gaultheriæ	♏v	or		30

M.—Triturate thoroughly.
Sig.—Use with toothbrush each evening.
For A. B., Oct. 10, 1902 (Chas. Dale.)

This formula is simply suggestive and admits of any desired modification or addition. Other ingredients and other proportions of these ingredients will be employed at pleasure. If we analyze the qualities of such a combination we find the value of each ingredient to be distinct, as here indicated:

Creta præparata is antacid and slightly abrasive.
Sapo is alkaline, detergent and antiseptic.
Oleum gaultheriæ is a flavoring agent.

It will be noticed that the Latin names of ingredients, and their adjectives, are given in the genitive case. The reason for this appears in the English version of the formula, the reading being: Take ten ounces *of* prepared chalk, etc.

The *antacids* that serve the same purpose as prepared chalk, but which are less abrasive, are magnesium oxide, magnesium carbonate, sodium bicarbonate and borax, the last-named being also antiseptic.

Powdered pumice and charcoal are too gritty and harsh for continued use. They may *injure* both the gums and the enamel, and they are, therefore, to be discarded from our formulas.

Powdered orris root (Radix Iridis Florentinæ) is valued by many,

because of its reputed tonic influence upon the mucous membrane, but it is not an antacid.

The *antiseptics*, other than soap, that may be employed, are borax, resorcin, naphtol and boric acid. The last named may be combined with sufficient antacid to leave the reaction of the mouth alkaline or neutral.

The *flavoring agents* include any of the pleasant volatile oils, or powdered drugs containing them—*e. g.*, powdered cinnamon. Some of the volatile oils are costly, and, therefore, not commonly used. Oil of rose is the most expensive. These oils are not included for any medicinal effect, but only as flavoring agents; therefore they are used in very small quantity.

Coloring agents, such as carmine or an aniline color, may be added if desired, but metallic pigments had better be avoided, for fear of staining exposed dentine.

If the dentifrice is preferred in form of a paste, sufficient glycerin may be added, but syrup or honey are to be avoided on account of being readily fermentable. For the same reason sugar is inferior as a sweetening agent. *Saccharine* may be used, as it does not ferment, and, being about 500 times sweeter than cane-sugar, a small quantity will suffice.

Anyone desiring his own special formula for a dentifrice can easily attain his object through a little experimentation with the substances here suggested, and the effort will be profitably expended. The thought should be prominent, however, that strong antiseptics are not constantly needed in normal conditions; and the more thoroughly the mouth and teeth are habitually cleansed the less will they be required.

Mouth Washes.—Washes for the mouth and teeth may be needed for the following purposes:

1. To *neutralize* acid fluids, whether introduced or present as abnormal secretion.

2. To *cleanse* the mouth.

3. To *disinfect* when ferments or septic bacteria are active.

4. To prevent, as an *antiseptic*, the growth of ferments and septic bacteria.

5. To exert an *astringent* action upon the mucous membrane.

6. To *stimulate* nutrition of the mucous membrane.

Many agents are employed to accomplish these purposes, and the possible combinations are without number. But it may be stated as a cardinal rule, that mouth washes should possess *antacid* and *antiseptic* properties. It is impossible even in health to maintain a strictly aseptic

condition of the mouth, while in disease, local or general, efforts are still less availing. It is often essential, therefore, that an antiseptic be freely employed, always, however, with due appreciation of the harm that may follow the improper use of the stronger agents.

Some agents addressed to a single purpose (as a detergent or an astringent) may be used alone in aqueous solution. Alcohol is not a suitable vehicle in mouth-washes unless its astringent action is desired, but its aid as a solvent may be necessary. In any case it must always be diluted.

The two main points to consider in prescribing a mouth wash are efficiency, and safety to the soft tissues.

Certain agents, including creosote, borax and boric acid, are regarded as quite efficient in a saturated aqueous solution and may be used freely without harming the tissues; but phenol, corrosive sublimate, chloride of zinc and formaldehyde would be very irritating in saturated solution. They must be very largely diluted for use in mouth washes.

One of the most efficient agents is phenol, but it should not be used stronger than 1 per cent.; and, though it is only very slightly acid in reaction, it is well to use an alkali with it as follows:

	Gm. or mil.	
℞.—Phenolis	2	(gr. xxx)
Sodii bicarbonatis	15	(ʒiv)
Glycerini	30	(℥j)
Aquæ . . . . . . q. s. ad	200	(f℥vij)—M.

Sig.—Use as mouth wash every three hours.

Another efficient similar combination in Dobell's solution. (See formula, p. 127).

The excellent work of Dr. W. D. Miller has shown benzoic acid and salicylic acid to be among our most efficient mouth antiseptics when used in 1 per cent. solution; but they are only slighty soluble in water, requiring 275 and 460 parts respectively, and they are *acid* in reaction. It is found, however, that with the aid of borax a 1 per cent. alkaline solution of either of these may be prepared; although it is probable that their antiseptic power is less in an alkaline solution. A saturated aqueous solution of borax, with 1 per cent. of either salicylic or benzoic acid added, is presented in the following:

	Gm. or mil.	
℞.—Sodii boratis	5	(ʒiss)
Acidi salicylici	1	(gr. xv)
Aquæ	100	(f℥iij)—M.

Dissolve the borax in the water, then add the salicylic acid.
Sig.—Mouth wash.

	Gm. or mil.	
℞.—Sodii boratis	5	(ʒiss)
Acidi benzoici	1	(gr. xv)
Aquæ	100	(fʒiij)—M.

Dissolve the borax in the water, then add the benzoic acid.
Sig.—Mouth wash.

Flavoring agents may be used in the above at pleasure, in the form of medicated waters, such as aqua cinnamomi, or a little volatile oil.

Creosote may be ordered in its official preparation:

	mil.
℞.—Aquæ creosoti	100

Sig.—Mouth wash. Use after each meal and at bedtime.

Hydrogen dioxide is entirely safe to use in the official 3 per cent. solution, but it is *acid* in reaction. It is useful in septic conditions.

ABBREVIATED TERMS USED IN PRESCRIPTIONS.

The use of abbreviations in the names of ingredients and in the directions to the patient is to be discouraged. The following list is intended more for reference in interpreting abbreviated prescriptions than for use in writing.

āā	ana	of each.
a. c.	ante cibum	before meals.
ad		to, up to.
adde		add.
ad. lib.	ad libitum	at pleasure.
aq.	aqua	water.
aq. bull.	aqua bulliens	boiling water.
aq. dest.	aqua destillata	distilled water.
aq. ferv.	aqua fervens	hot water.
b. i. d.	bis in die	twice daily.
Br. P.		British Pharmacopœia.
c.c.		cubic centimeter.
cg.		centigram.
chart.	charta, chartula	a paper, a little paper.
cochl. mag.	cochleare magnum	tablespoon.
cochl. med.	cochleare medium	dessertspoon.
cochl. parv.	cochleare parvum.	teaspoon.
collyr.	collyrium	eye wash.
collut.	collutorium	mouth wash.
co., comp.	compositus, a, um	compound.
cong.	congius	gallon.
cort.	cortex	bark.
cum		with.
dil.	dilutus, a, um	diluted.
div.	divide	divide.
ext.	extractum	extract.
ft.	fiat, fiant	let (it) (them) be made.
fl.	fluidus, a, um	fluid.
fol.	folia	leaves.

gtt.	gutta, guttæ	drop, drops.
gm.		gram.
gr.		grain.
h. s.	hora somni	at bed-time.
in d.	in die	daily.
L.		liter.
liq.	liquor	solution.
mil.		milliliter.
♏.		minim.
M.	misce.	mix.
mist.	mistura	mixture.
N. F.		National Formulary.
no.	numerus, numero	number, in number.
noct.	nocte	by night.
non. rep.	non repetatur	let it not be repeated.
O.	octarius	pint.
ol.	oleum	oil.
o. m.	omni mane	every morning.
omn. bih.	omni bihora	every two hours.
omn. hor.	omni hora	every hour.
omn. noct.	omni nocte	every night.
part. æq.	partes æquales	equal parts.
p. c.	post cibum	after meals.
pil.	pilula	pill.
p. r. n.	pro re nata	as occasion arises.
pulv.	pulvis	powder.
q. i. d., q. d.	quater in die	four times a day.
q. s.	quantum sufficit	as much as necessary.
℞	recipe	take.
rad.	radix	root.
rect.	rectificatus	rectified.
rep.	repetatur	let it be repeated.
s. a.	secundum artem	according to art.
ss.	semissis	a half.
S., Sig.	signa	sign (write).
	or	
	signetur	let it be labeled.
sine		without.
solv.	solve	dissolve.
spir.	spiritus	spirit.
sp. gr.		specific gravity.
syr.	syrupus	syrup.
tab.	tabella	tablet, troche.
tal.	talis	such, like this.
t. i. d., t. d.	ter in die	three times a day.
tinct., tr.	tinctura	tincture.
trit.	tritura	triturate.
troch.	trochiscus	troche, lozenge.
ung.	unguentum	ointment.
U. S. P.		United States Pharmacopœia.
vel.		or.
vin.	vinum	wine.
wt.		weight.

CHAPTER XXII.

POISONS.

A POISON may be defined to be a substance which, when introduced into the body, causes disease or death. But, in accepting this definition, foreign bodies or agents that act mechanically must be excluded, as, for example, a bullet. Certain substances also that produce disease in the system are not usually classed among poisons. Of these there are:

Venom, the natural protective secretion of certain reptiles and insects.

Virus, a rather indefinite term that has been applied to the microbic cause of an infectious disease or to the characteristic poison developed in course of the disease.

With the recognition of the definite organisms that cause the several infectious diseases the term *virus* has fallen somewhat into disuse. In its place we have the more definite terms of *bacterium,* as the cause, and *toxin,* a poisonous product of the growth of the bacterium.

[*Antitoxin* is a substance formed in the body as a reactionary protection against the action of a toxin of a disease. The presence of a toxin is necessary to stimulate the formation of the antitoxin which is capable of neutralizing it. The most familiar example of an antitoxin is that of diphtheria, which is prepared in the blood of the horse and used to neutralize the toxin of the disease in the human being.]

Ptomains are basic organic compounds formed by the action of bacteria upon nitrogenous matter. Some are poisonous, and some resemble vegetable alkaloids in their action.

Leukomains are basic substances that result from tissue metabolism. Some of these are poisonous.

The usual use of the term poison refers to drugs that, when taken in overdose or in concentrated form, produce disease or death.

The law recognizes the responsibility that attaches to the sale of poisons, and requires, in most communities, that all poisons, except those dispensed upon a physician's prescription, shall be distinctly labeled, and, in case of the more powerful substances, that a record shall be made of the sale.

The substances included in the list of poisons vary very greatly in their action, as to time required for their poisonous effects, part of the

system attacked, and character of symptoms produced. Thus arsenic, one of the most destructive poisons, acts slowly, while carbolic acid may cause death in a very short time, as is true also of hydrocyanic acid. Strychnine causes frightful convulsions, while morphine produces coma. The simple outline here given serves to aid in grouping poisons according to site of action:

1. Those acting locally:
   (*a*) Corrosives.
   (*b*) Irritants.
2. Those acting upon the blood, or blood poisons.
3. Those acting upon the nervous system, or nerve poisons.
4. Those acting upon special organs:
   (*a*) Upon heart.
   (*b*) Upon kidneys.
   (*c*) Abortives.

Concerning abortives, it should be noted that they are really irritants. Among other effects they may disturb the gravid uterus, but this is only one of the dangers of their action. As a class they must be regarded as very dangerous agents and at the same time uncertain as to any special action.

(For symptoms and treatment of poisoning by the various substances, see Table of Poisons and Antidotes.)

Modes of death are appropriately defined at this place as related to poisons.

1. *Failure of Circulation.*—**Syncope** is sudden failure of the circulation, due to depression of the heart from various causes. It may be temporary, as in case of ordinary fainting, or it may be complete, due to paralysis of the heart.

Asthenia is gradual failure of the circulation by depression of the heart, as occurs in fatal cases of acute infectious diseases.

2. *Failure of Respiration.*—**Asphyxia** is the condition of non-oxygenation of the blood. It may be caused by complete shutting off of the air (apnea), as in drowning, or it may be due to the displacement of oxygen by other gases. It may be partial or complete.

3. *Paralysis of Brain Centers.*—**Coma** is a paralysis of the conscious and the reflex centers of the brain. It may be caused by pressure, as in apoplexy, or it may be due to the action of a narcotic.

The *signs of death* usually relied upon are cessation of respiration, cessation of circulation and paralysis of pupil.

TABLE OF POISONS AND ANTIDOTES.

(This table is adapted from the author's Tables for Doctor and Druggist, by permission of the publisher, E. G. Swift, Detroit, Mich.)

Poison.	Toxic dose.	Action.	Prominent symptoms.	Antidotes and treatment. (*Antidotes in italics.*)
Acid, carbolic (phenol)	gr. 5	Corrosive; systemic poison	Pain followed by numbness; white stain; collapse; stupor; dyspnea	Emesis: *Albumin, alcohol, sulphate of magnesium* or other *soluble sulphate;* oil or other demulcents; stimulants.
Acid, hydrocyanic, Acid, prussic (U. S. P. 2%) Bitter almond, oil Potass. cyanide	♏30 gr. 3–4 fatal	Depresses brain and heart	Sudden various symptoms of depression; dyspnea	Artificial respiration; stomach tube; cold douche to head and chest, or alternate with hot; ammonia inhalation; mixture of *persulphate* and *protosulphate of iron.*
Acid, oxalic . . . Soluble oxalates	ʒ4	Irritant; general depressant	Abdominal pain, vomiting, collapse, stupor	*Carbonate of lime* in any form, *magnesia, lime-water;* anodynes, demulcents, stimulants.
Mineral acids. Acid, hydrochloric, nitric, sulphuric,	*	Corrosive	Thirst, vomiting, burning pain in throat and stomach; tissues corroded; more or less collapse	Glass of water† *immediately* to dilute acid, follow by *lime-water, magnesia, soap* or *plaster from wall; no carbonates;* demulcents, stimulants; morphine hypoderm. if needed; do not use stomach pump.
Aconite . . . . Tincture of root Aconitine	. . . ♏22 gr. 1/60	Depresses heart and nervous system	Tingling and numbness; slow, weak pulse; dyspnea; pupil usually dilated	Empty stomach; atropine, ammonia, digitalis with glonoin; strychnine; slight galvanic shock recommended; *tannin* in aconitine poisoning.
Ammonia . . . Water of (10%)	. . .	Irritant	Irritation in air passages and stomach with pain, vomiting and purging; prostration; odor of ammonia	Water immediately to dilute, follow by *lemon-juice* or *vinegar.* Inhalation of *acetic acid vapor;* stomach pump should not be used; demulcents, anodynes, stimulants.
Stronger water of (28%) Carbonate of ammonium	f℥1* fatal	Caustic		
Arsenic trioxide . . Arsenous acid, white arsenic . Arsenic disulphide, red sulphide of arsenic, realgar Arsenic trisulphide, orpiment, King's yellow Arsenite of copper . Scheele's green Aceto-arsenite of copper; Paris green; Schweinfurth green	. . . gr. 2 fatal	Escharotic; irritant when diluted	Faintness; gastro-intestinal irritation, vomiting and purging, thirst; collapse; cramps, convulsions or coma; in some cases *collapse* is most prominent symptom, in others *stupor;* some cases resemble *cholera;* usually the symptoms do not develop quickly	Aid emesis (unless vomiting has been profuse) by the use of mustard or sulphate of zinc; may wash out stomach by means of flexible tube, but stomach pump should not be used; freshly prepared *hydrated sesquioxide of iron*‡ freely, and follow by an emetic, then by castor oil; demulcents anodynes, stimulants, external warmth.
Belladonna (leaves, berries or root) . Atropine . . .	. . . gr. ½–¾ fatal	Deliriant narcotic; dilates pupil and paralyzes accommodation	Dryness of mouth and pharynx; eyes bright, pupils dilated; face flushed; rapid respiration; delirium, convulsions, stupor	Emetics or stomach tube; *tannic acid, animal charcoal,* follow by emetic, and later by castor oil; heat or cold externally, or alternately; artificial respiration and stimulants if necessary; morphine may be of value.
Bromine: By stomach . .	. . .	Caustic; sedative to nerve centers	Severe symptoms of irritation; depression of nerve centers; paralysis	Dilute with large draughts of water; very dilute solutions of *alkalies;* ether; brisk cathartic *alkalies.*
By inhalation . .	. . .	. . . . .	. . . . . .	Ammonia by inhalation.

* Poisonous effect depends more upon concentration than upon quantity.

† There can be no objection to the use of water in sulphuric acid poisoning, if sufficient is employed. In mixing 100 c.c. of water at 70° F. with 10 c.c. of sulphuric acid, the temperature increased to only 111° F.; and in mixing 200 c.c. of water (a glassful) with 10 c.c. of sulphuric acid, the temperature increased to only 94° F.

‡ This is the Ferri Hydroxidum, U. S. P. To prepare it freshly use tincture of chloride of iron, Monsel's solution, or solution of tersulphate of iron (any solution of a *ferric* salt) and milk of magnesia. Dilute the iron solution with several times as much water, also the milk of magnesia with an equal quantity. Mix the two and administer freely *at once*, giving one-half to one glassful (100 to 200 mils.) of the mixture. [Water of ammonia may be substituted for the milk of magnesia, but the product requires washing to remove the sharp taste and odor of ammonia.]

Poison.	Toxic dose.	Action.	Prominent symptoms.	Antidotes and treatment. (*Antidotes in italics.*)
Camphor	gr. 20	Disturbs brain and nerve centers	Vertigo; pain in stomach; delirium or stupor; convulsions	Emesis; follow by castor oil or sulphate of magnesium; stimulants if necessary to support nerve centers.
Cannabis indica	...	Intoxicant	Hilarity; mental confusion; pupils dilated; drowsiness	Meet indications as they arise (there is no case on record of fatal poisoning by this drug).
Cantharides Tincture Cantharidin (active principle)	gr. 23 f℥1 fatal ..	Irritant; sometimes aphrodisiac	Gastro-intestinal irritation with pain, vomiting and purging; pain in loins; severe irritation of genito-urinary organs; sometimes erotic excitement; collapse, stupor, coma; in some cases delirium or convulsions	Emesis; stomach tube may be used; demulcents; no oils should be employed, as they dissolve cantharidin and favor its absorption; anodynes by the rectum; opium, cocaine, belladonna; morphine hypodermically, or anesthetics if suffering is intense; leeches to hypogastrium; warm baths; mild diuretics and cathartics.
Carbolic acid; *see* Acid, carbolic				
Carbonic anhydride,* carbonic acid gas	...	Regarded as narcotic	Headache, giddiness, drowsiness; cyanosis if oxygen is excluded	Supply fresh air or oxygen; artificial respiration and stimulants if necessary.
Carbonic oxide† Charcoal gas Coal gas Illuminating gas	...	Destroys oxygen-carrying power of the red blood corpuscles	Headache, vertigo, prostration, vomiting, dyspnea; feeble and rapid pulse, stupor; in some cases convulsions	The hemoglobin being so altered as to be incapable of taking up oxygen, the treatment by fresh air and oxygen is not so successful as in simple asphyxia; still this means of giving oxygen to the blood cells that remain uninjured should be employed; in urgent cases transfusion of blood.
Castor-oil beans (seeds of Ricinus communis)	Three seeds fatal	Irritant	Severe gastro-intestinal irritation	Emesis, demulcents, anodynes and stimulants if necessary.
Chloral hydrate	gr. 30	Hypnotic; sedative; paralyzes nerve centers; narcotic	Stupor; pupils at first contracted, later dilated; temperature reduced; respirations slow, or later may be rapid and shallow	Emesis or stomach tube; external warmth very important;‡ arouse patient; stimulate reflexes by external application of mustard, friction, slapping smartly; faradization; atropine, strong coffee, strychnine, ammonium carbonate and digitalis if urgent; artificial or forced respiration; oxygen.
Chloroform	...			
By stomach	f℥4 fatal to adult; f℥1 to child	Locally irritant; anesthetic	When taken by the stomach: gastric irritation, vomiting, odor of chloroform; later, stupor, coma	Emetic or use of stomach tube; arouse patient; recumbent posture; stimulants; strychnine, caffeine, digitalis; external warmth, artificial respiration if necessary.
By inhalation	♏15 quickly inhaled has been fatal	Anesthetic; paralyzes nerve centers; may paralyze heart	When inhaled: loss of consciousness; syncope sometimes early; profound narcosis; death by failure of heart or respiration	Stop inhalation and supply fresh air; head low to favor gravitation of blood to the brain; artificial respiration, external warmth and friction; faradization to muscles of respiration; massage of heart; strychnine, caffeine, digitalis.
Coal gas; *see* Carbonic oxide				
Cocaine Cocaine hydrochloride	gr. ¼ or less gr. ½ fatal	Stimulant; later depressant; locally paralyzant	Faintness and collapse, or delirium, or convulsions; symptoms irregular	*Tannic acid, potassium permanganate* or *purified animal charcoal;* empty stomach; treat conditions as they arise.
Copper salts Arsenite; *see* Arsenic Carbonate "Natural" verdigris Subacetate, verdigris Sulphate, blue vitriol	... ℥4 ℥1 fatal.	Irritant	Gastric irritation with pain and vomiting of greenish matter, purging; jaundice in some cases; convulsions or paralysis may follow.	Aid emesis; *albumin* freely is best antidote; milk, mucilaginous drinks; *ferrocyanide of potassium* if pure; opium; stimulation if necessary.

* An atmosphere containing 1 to 2 per cent. of carbonic anhydride, with a corresponding diminution of oxygen, is poisonous; with 5 to 10 per cent. of carbonic anhydride, and oxygen correspondingly lessened, death will occur, while it requires 10 to 20 per cent. to extinguish a flame.

† Carbonic oxide is more poisonous. According to Sollmann (Pharmacology) it combines with hemoglobin 200 times more readily than does oxygen.

‡ Brunton and Stricker found that animals which had received a dose of chloral that would certainly kill them if they were left exposed, recovered when wrapped up in cotton-wool, and if the dose were increased so as to kill the animal even when thus wrapped up, it could still be kept alive by being put into a warm place so as to keep up its temperature artificially. A still larger dose was fatal.

Poison.	Toxic dose.	Action.	Prominent symptoms.	Antidotes and treatment. (*Antidotes in italics.*)
Corrosive sublimate; *see* Mercuric chloride.				
Creosote	...	Irritant	Gastro-intestinal irritation	Dilute freely with water, then emesis; follow by demulcents.
Croton oil.	♏30 fatal	Irritant; drastic cathartic	Violent gastrointestinal irritation; purging, collapse and other symptoms resembling those of cholera	Demulcents, anodynes; morphine hypodermically.
Cyanide of potassium; *see* Acid, hydrocyanic				
Elaterium Elaterin (several times stronger than elaterium)	...	Drastic cathartic	Violent vomiting and purging with severe griping; collapse	Anodynes, morphine hypodermically, demulcents, stimulants.
Ether, by stomach	...	Irritant	Gastro-intestinal irritation	Stimulate elimination; demulcents; stimulants if needed.
by inhalation	...	Anesthetic	Narcosis; cessation of respiration	Stop inhalation; abundance of fresh air; artificial respiration, external warmth, strychnine, caffeine; faradization.
Formalin	...	Irritant	Severe pain in throat and stomach; vomiting	Dilute poison with warm water freely; if vomiting does not occur the stomach should be thoroughly washed by means of tube; demulcents, anodynes; *ammonia* as antidote.
Fungi* Amanita muscaria, Agaricus phalloides and others (the irritant principle is destroyed by boiling, drying, or by acids, alkalies or alcohol; but the narcotic principle, *muscarine*, resists the action of heat, drying, or these reagents)	...	Irritant; narcotic	Gastro-intestinal irritation, pain and vomiting; various nervous symptoms; headache, vertigo, visual disturbances; in some cases delirium or coma	Emetic and cathartic (common salt or mustard as emetic); demulcents and other treatment according to indications; atropine hypodermically is recommended as physiological antidote; *tannic acid* has been thought to be useful; *purified animal charcoal.*
Hyoscyamus, henbane Hyoscyamine Hyoscine	...	Similar to belladonna; but more hypnotic	Same as in belladonna poisoning	Same as for belladonna poisoning.
Iodide of potassium (acute poisoning)	...	Irritant	Gastro-intestinal irritation, vomiting and purging; headache, in some cases salivation; frequently an eruption; prostration	Aid emesis; demulcents, diluents, anodynes, stimulants if needed.
Iodine (acute poisoning) Tincture.	...	Irritant	Similar to above	*Starch* freely, follow by evacuants; other treatment as above.
Iron salts Chloride, tinct. of Sulphate, copperas	...	Irritant	Gastric irritation and pain; vomiting	Dilute with draught of water immediately; dilute solution of *sulphide of potassium, sodium* or *ammonium;* aid emesis by large draughts of warm water; demulcents, anodynes; stimulants.
Laudanum. *See* Opium				
Lead salts Acetate; sugar of lead Carbonate; white lead Oxide, red; red lead	...	Irritant in acute poisoning	Gastro-intestinal irritation with severe colic, vomiting, constipation; if severe, convulsions may occur	Aid emesis; *sulphate of magnesium* or other soluble *sulphate,* followed by emetic; stimulate sweating by external warmth; later *iodide of potassium* or very dilute *sulphuric acid,* or both.
Mercuric chloride (corrosive sublimate; bichloride of mercury) Mercuric cyanide (similar to above)	gr. 3 fatal	Corrosive	Symptoms occur quite promptly; burning in throat and stomach, nausea and vomiting; abdomen swollen and tender; severe purging with straining; discharges frequently bloody; collapse, stupor, convulsions	*Albumin* freely (white of one egg to each 0.25 gm. (4 grains) of poison swallowed); as a substitute for albumin *wheat-flour* paste or *milk;* emesis after poison is neutralized; demulcents, morphine hypodermically; stimulants internally and heat or friction externally; continue white of egg for one to two weeks.

* For an extensive and illustrated description of edible and poisonous fungi, see Reference Handbook of the Medical Sciences, vol. iii, New York.

Poison.	Toxic dose.	Action.	Prominent symptoms.	Antidotes and treatment. (*Antidotes in italics.*)
Mercury salts . . (The salts other than bichloride and cyanide are toxic in proportion to solubility)	. . .	Irritant	Symptoms of gastro-intestinal irritation in varying degree, according to the amount and solubility of salt	Prompt emesis by mustard or sulphate of zinc; follow by *albumin* or *milk*, after which induce further emesis and purgation; meet other indications as they arise.
Morphine *See* Opium.				
Nitrite of amyl . . Nitroglycerin, glonoin	. . .	. .	Flushing of face, succeeded by pallor; pupils dilated; respiration irregular; pulse weak	Cold to head, artificial respiration, ergot, strychnine, digitalis; warmth externally.
Nux vomica . . . Alcoholic extract, Strychnine . .	gr. 30 gr. 3 gr. $\frac{1}{3}$	Increases irritability of spinal cord	Muscular twitching; tonic spasms, with intervals of rest; extreme extension of back so that body may rest upon the heels and head; corners of the mouth drawn up; later jaws become fixed; death by asphyxia or exhaustion; consciousness remains until near death	If seen early evacuate stomach, then give *tannic acid* freely, and follow by a quick emetic; bromide of sodium in large doses, gm. 4–16 (ʒ1–4), every half hour, if necessary; chloral, gm. 1–2 (gr. 15–30); keep patient very quiet; when convulsions are severe, inhalations of ether or chloroform; forced respiration* if asphyxia threatens; curarine hypodermically has been suggested; bladder should be emptied.
Opium. . . . . Camphorated tincture; paregoric (contains about $\frac{1}{4}$ grain of opium to a fluidrachm) Tincture; laudanum (this and all other fluid preparations except paregoric contain 10% of opium)	gr. 4–5 fatal	1st stage	Often slight stimulation or excitement	Evacuate stomach by use of mustard stirred up in lukewarm water, aided by sulphate of zinc, gm. 1.3–2 (gr. 20–30) if vomiting does not speedily occur; meanwhile *tannic acid* should be given freely, or *potassium permanganate;* wash out stomach; the stomach tube may be useful; apomorphine 0.005 gm. ($^{1}/_{12}$ gr.) hypodermically as emetic if patient cannot swallow.
Codeine Morphine . . . Narcotine Heroin	gr. $\frac{1}{2}$ fatal	2d stage narcotic	Intoxication, drowsiness and stupor; pupils are contracted; pulse slow and full; respiration slow and often stertorous; face flushed, sometimes cyanosed; unconsciousness seems complete; but patient can be partially aroused during this stage by shaking or shouting	Maintain respiration: (1) By arousing patient and stimulating reflex activity by external stimulation, shouting, smart slapping, frictions; faradization, alternate douche of quite hot (as hot as the hand can bear) and ice-cold water to head and chest; cautious inhalations of ammonia; (2) by strong coffee freely or caffeine hypodermically; atropine hypodermically in ordinary doses only, to be repeated according to the state of the respiration; strychnine. (3) If respiration is slow, or rapid and shallow, so that in either case insufficient air enters the lungs, artificial respiration or forced respiration† must be employed without intermission until proper respiration is established; inhalation of oxygen; catheterization should not be neglected, and large enemata of warm water may aid elimination.

* See note under Opium.

† The principle of forced respiration, as practised in physiological experiments was applied to the treatment of opium poisoning by the late Dr. George E. Fell, of Buffalo, N. Y. The apparatus used consists of bellows, face-mask and the necessary rubber tubes, with stopcock arranged to facilitate imitation of the natural respiratory rhythm, and to allow the addition of oxygen to the inspired air. Dr. Fell employed the method in eleven cases that seemed hopeless with the use of ordinary means of treatment and in three cases that were absolutely hopeless. Of the eleven cases eight were saved. The pulmotor is an apparatus that supplies oxygen in connection with forced respiration. In expert hands it is efficient, but is not so commonly available as ordinary artificial respiration.

Poison.	Toxic dose.	Action.	Prominent symptoms.	Antidotes and treatment. (*Antidotes in italics.*)
		3d stage, paralyzant	Prostration, coma; respiration may become more rapid and shallow, but is usually slow then ceasing entirely; pulse weaker and more rapid; face is cyanosed, though sometimes pallid; before death occurs pupils become dilated; reflexes abolished; convulsions may occur; death usually by failure of respiration	Sustain circulation; strychnine, caffeine, external heat and friction; digitalis if heart failure threatens; strong infusion of coffee by enema; keep up artificial or forced respiration with or without oxygen; morphine is eliminated into the stomach, therefore it should be washed out frequently with a solution of *potassium permanganate.*
Oxalates, Oxalic acid } See Acid, oxalic				
Paregoric; *see* Opium				
Paris green; *see* Arsenic				
Phosphorus . . .	gr. 1 fatal	Irritant	Symptoms usually do not appear until after a few hours; then weakness, nausea with vomiting, and other symptoms of gastric irritation; vomited matters are luminous in the dark, and have the odor of phosphorus; later jaundice and in some cases delirium, convulsions, coma; hemorrhages may occur; temperature may be greatly reduced; in some cases death occurs early and symptoms are not typical	*Sulphate of copper,* 0.2 gm. (3 grains) in dilute solution every five minutes as antidote and to induce emesis; if at hand *crude acid French oil of turpentine,* or, as a substitute for it, *old oxidized oil of turpentine,* and follow by a quick saline cathartic; ordinary turpentine is of no value and may be dangerous, as oils should be avoided because they are solvents for phosphorus; after poison is neutralized and removed employ demulcents; mucilaginous drinks, anodynes and stimulants if necessary.
Potassa . . . . Soda (Soda as a poison is very similar to potassa.) Liquor potassæ Liquor sodæ Commercial potash and soda are impure carbonates containing much free alkali	ʒ4*	Caustic	Burning and pain in stomach and abdomen; severe vomiting and purging; prostration	A large draught of water immediately, and follow with diluted *vinegar* or *lemon-juice;* albumin, oils, acidulated demulcent drinks; opium or morphine to relieve pain; stimulants.
Potassium bitartrate; cream of tartar	℥2 fatal	Irritant; purgative	Gastro-intestinal irritation	Demulcents; *chalk* or *magnesia* mixed with water; opium.
Potassium chlorate .	℥1 fatal	Irritant believed to produce serious changes in the blood	Gastro-intestinal irritation with pain and vomiting; irritation of kidneys, often with suppression of urine and other symptoms of acute nephritis; cyanosis and nervous symptoms may occur	Demulcents, saline purgatives and diuretics; calomel may be valuable; coffee or caffeine; stimulants moderately; heat externally; transfusion of blood is recommended.
Potassium nitrate .	ʒ6 fatal	Irritant	Gastro-intestinal irritation with violent vomiting, and in some cases purging; muscular weakness, collapse; various nervous symptoms may occur	Dilute at once with large draught of warm water and promote emesis; give brisk non-irritating cathartic; follow by demulcent drinks; keep patient warm; anodynes and stimulants as needed; if collapse occurs, warmth, friction, or mustard externally.
Potassium sulphate .	ʒ10 fatal	Irritant	Similar to above	Same as for potassium nitrate.
Prussic acid; *see* Acid, hydrocyanic				
Red lead; *see* Lead salts				
Red precipitate; *see* Mercury salts				

* Poisonous effect depends rather upon concentration than quantity.

Poison.	Toxic dose.	Action.	Prominent symptoms.	Antidotes and treatment. (*Antidotes in italics.*)
Silver nitrate . .	. . .	Irritant	Severe gastric irritation, vomiting, convulsions; later diarrhea	Solution of *common salt* freely; *albumin;* mucilaginous drinks; other treatment as the case may require.
Soda; *see* Potassa				
Stramonium (Similar to belladonna as a poison); *see* Belladonna				
Strychnine; *see* Nux vomica				
Sugar of lead; *see* Lead salts				
Tobacco	gr. 30	Irritant; sedative	Nausea, vomiting, in some cases purging; pain in stomach; prostration; delirium; cramps; rapid, weak pulse; collapse	Aid emesis by large draughts of warm water; *tannic acid;* strychnine, demulcents, anodynes, stimulants, external warmth, etc.
Nicotine (one of the most active poisons known)	A few drops probably fatal			
Turpentine, oil of .	. . .	Irritant; narcotic	Gastric irritation; vomiting and purging in some cases; irritation of urinary organs with urine lessened; unconsciousness; convulsions; collapse	Evacuate stomach by use of mustard or stomach tube, or if vomiting has occurred aid by large draughts of warm water; sulphate of magnesium as cathartic; hot fomentations to loins; demulcents; stimulants and anodynes if needed; warmth and friction externally.
Verdigris; *see* Copper salts				
White lead; *see* Lead salts				
Zinc chloride . . . "Burnett's Disinfecting Fluid" has 200 grains of zinc chloride in one fluidounce	. . .	Corrosive	Violent irritation of stomach immediately, with vomiting and pain; tissues corroded; nervous symptoms; collapse	A glassful of milk or water immediately to dilute poison; *albumin;* dilute solution of *carbonate of potassium* or *sodium;* demulcents, anodynes, stimulants.
Zinc sulphate . .	ʒ2–4	Irritant; emetic	Gastric irritation; vomiting	Dilute solution of *carbonate of potassium* or *sodium,* or *tannic acid; albumin;* demulcents; anodynes and stimulants if necessary.

INDEX OF DRUGS.

OFFICIAL DRUGS AND PREPARATIONS ARE GIVEN THEIR PHARMACOPŒIAL TITLES.

(Doses and uses are adapted from the author's Tables for Doctor and Druggist, by permission of the publisher, E. G. Swift, Detroit.)

Abbreviations: Ac. = acid. Al. = alkaline. Insol. = insoluble. Misc. = miscible. N. = neutral. Part. = partly soluble. Sl. sol. = slightly soluble. V. s. = very soluble. Spar. = sparingly soluble.

* Unofficial.

Page in text.	Drug.	Reaction.	Solubility in		Dose.		Uses.
			Water.	Alcohol.		Gm. or mil.	
90	Acacia, gum Arabic	..	2	insol.	.....	.....	*Demulcent:* In irritation in digestive tract; in emulsions to hold oil or other matter in suspension
	Mucilago acaciæ, 35%	ac.	...	...	.....	Freely	
	Syrupus, 10%	ac.	...	...	.....	Freely	
143 240	Acetanilidum, antifebrin	N.	190	3.4	gr. 1–5	0.06–0.30	*Antipyretic, Anodyne:* In acute fevers cautiously; in headaches; locally in powder as *antiseptic.*
	*Pulvis acetanilidi compositus	..	...	...	gr. 2–15	0.12–1	
161	*Acetozone, benzoyl-acetyl peroxide, benzozone	..	sl. sol.	...	gr. 1–5	0.06–0.30	*Antiseptic; bleaching agent.*
240	Acetphenetidinum, phenacetin	..	1310	15	gr. 2–10	0.12–0.60	*Antipyretic, Anodyne:* In headaches.
	Acidum aceticum, 36%	ac.	...	...	local use	.....	*Solvent:* To soften callous tissue, corns, etc; *hemostatic.*
	Acidum aceticum dilutum, 6%	ac.	...	...	♏15–60	1–4	
73	Acidum aceticum glaciale, 99%	ac.	...	...	.....	.....	*Caustic.*
241	*Acid, acetylsalicylic, aspirin	ac.	300	3	gr. 5–20	0.30–1.30	*Anodyne, Antipyretic:* In rheumatism, headaches.
	Acid, arsenous; *see* Arseni trioxid						
134	Acidum benzoicum	ac.	275	2.3	gr. 5–20	0.30–1.30	*Antiseptic:* The acid and its combinations given internally as urinary antiseptics.
	Ammonii benzoas	N.	10	35.5			
	*Lithii benzoas	sl. ac.	3	13			
	Sodii benzoas	N.	1.8	61			
126	Acidum boricum, boric acid	sl. ac.	18	18	gr. 5–15	0.30–1	*Antiseptic:* Saturated aqueous solution as mouth wash or to purulent inflammations; borax has similar uses, is alkaline and antiseptic.
120 126	Sodii boras, borax	al.	15	insol.	gr. 5–20	0.30–1.30	
126	Glyceritum boroglycerini (a soln. of boroglycerin, 31% boric acid)	N.	...	...	local use	.....	
	*Acidum camphoric	ac.	125	sol.	gr. 10–30	0.60–2	To control night-sweats of phthisis.
	Acid, carbolic; *see* Phenol						
	Acid, chromic; *see* Chromii trioxid						
133	*Acid, cinnamic	ac.	sl. sol.	sol.	.....	.....	*Antiseptic:* Similar to benzoic acid.
230	Acidum citricum	ac.	0.5	1.8	gr. 5–20	0.30–1.30	*Restorative tonic:* In scurvy, as a substitute for lemon-juice.
	Syrupus acidi citrici, 1%	..	...	...	f℥1–4	4–15	
108	Acidum gallicum	ac.	87	5	gr. 5–20	0.30–1.30	*Astringent:* as systemic *hemostatic.*
71 291	Acidum hydrochloricum, 32%	ac.	...	...	.....	.....	*Caustic.*

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
229	Acidum hydrochloricum dilutum, 10%	ac.	...	...	♏5–20	0.30–1.20	*Digestant:* when acidity of gastric juice is deficient.
228 239 291	Acidum hydrocyanicum dilutum, dil. prussic acid, 2%	ac.	...	...	♏1–3	0.06–0.20	*Sedative:* in cough and vomiting; use with caution.
73	Acidum lacticum, 85–90%	ac.	sol.	sol.	♏15–60	1–4	*Antiseptic; Solvent:* Applied to diphtheritic membrane and in pyorrhea alveolaris.
	Acid, muriatic; *see* Acid hydrochloric						
71 291	Acidum nitricum, aqua fortis, 68%	ac.	...	...	.....	.....	*Caustic:* Locally to sloughing ulcers, and caries of bone; dilute acid as *tonic* and *stimulant* to liver and digestive secretions.
229	Acidum nitricum dilutum, 10%	ac.	...	...	♏5–20	0.30–1.20	
71	Acidum nitrohydrochloricum, aqua regia	ac.					
230	Acidum nitrohydrochloricum dilutum	ac.	...	...	♏5–20	0.30–1.20	*Tonic; Digestant:* Same uses as dilute hydrochloric and nitric acids.
	Acidum oleicum	sl. ac.	insol.	sol.	.....	extern.	To prepare oleates.
291	*Acid, oxalic	ac.	8	2.5	.....	.....	*Irritant poison:* As reagent; to remove stain of potassium permanganate, or of rust, fruits and ink.
	Acidum phosphoricum, 86%	ac.					
231	Acidum phosphoricum dilutum, 10%	ac.	...	...	♏5–30	0.30–2	*Restorative tonic:* In neurasthenia.
	*Acid, picric, carbazotic acid	ac.	86	sol.	.....	.....	*Reagent; Coloring agent.*
134	Acidum salicylicum	ac.	460	2.7	gr. 5–20	0.30–1.30	*Antiseptic; Antipyretic:* As preservative; salicylates in acute rheumatism.
	*Ointment, 10%	..	...	...	.....	extern.	
	Ammonii salicylas	N.	1	3	gr. 5–15	0.30–1	
135	Sodii salicylas	sl. ac.	0.9	9.2	gr. 5–30	0.30–2	
	Strontii salicylas	..	19	61	gr. 5–30	0.30–2	
71 291	Acidum sulphuricum, 94%	ac.	...	...	.....	.....	*Corrosive:* Dilute acid as *astringent.*
230	Acidum sulphuricum dilutum, 10%	ac.	...	...	♏5–20	0.30–1.20	The aromatic acid as solvent for quinine-sulphate.
230	Acidum sulphuricum aromaticum	..	...	...	♏5–20	0.30–1.20	
162	Acidum sulphurosum, 6% of sulphur dioxide gas	ac.	...	...	f℥$\frac{1}{2}$–2	2–8	*Disinfectant; Bleaching agent:* In parasitic skin diseases; internally in form of sulphites or thiosulphate, as *antiseptic.*
162	*Sodii bisulphis	ac.	3.5	70	gr. 5–30	0.30–2	
	Sod. sulphis exsiccat.	N.	2	sl. sol.			
147 163	Sodii thiosulphas (hyposulphite)	N.	0.5	insol.			
96	Acidum tannicum	ac.	0.33	0.22	gr. 1–30	0.06–2	*Astringent:* Applied as *hemostatic;* to contract tissue as in catarrhal pharyngitis, and to check secretion, as in diarrhea.
114	*Collodium stypticum, 20%	..	...	...	local use		
93	Glyceritum acidi tannic, 20%	..	...	...	local use		
	Unguentum, 20%	..	...	...	local use		
	Trochisci	..	...	...	gr. 1 each		
230	Acidum tartaricum	ac.	0.75	3.3	gr. 5–20	0.30–1.30	Substitute for citric acid or lemon-juice.
73	Acidum trichloraceticum	ac.	v. s.	v. s.	.....	.....	*Caustic:* Test for albumin.
239 291	Aconitum, aconite root (a. napellus)	..	...	...	gr. $\frac{1}{4}$–1	0.15–0.06	*Cardiac sedative:* To reduce arterial pressure in inflammation and sthenic fevers; locally sedative in form of plaster, tincture, or the oleate of aconitine, in neuralgia.
Plate	Extract	..	...	...	gr. $\frac{1}{10}$–$\frac{1}{4}$	0.006–0.015	
xiv	Fluidextractum aconiti	..	...	...	♏$\frac{1}{4}$–1	0.15–0.06	
64, 65	Tinctura aconiti, 10%	..	...	...	♏5–15	0.30–1	
291	Aconitina, aconitia	al.	3200	22	gr. $\frac{1}{400}$	0.00015	
	*Oleate of aconitine, 2%	..	...	...	local use		
	Actol; *see* Argenti lactas						
91	Adeps, lard	..	...	...	.....	extern.	As basis for ointments; benzoinated lard keeps better than ordinary.
	Adeps, benzoinatus						

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
91	Adeps lanæ, lanolin (purified fat of sheep's wool)	..	misc.	spar.	.....	extern.	Lanolin has advantage of being able to hold an aqueous solution.
	Adeps l. hydrosus, hydrous wool-fat, contains about 30% of water						
107	*Adrenalin (claimed to be the crystalline active principle of suprarenal glands)	..	...	...	Chiefly local use		Preparations from the adrenals are *arterial stimulants* injected intravenously, and *hemostatics* locally; to constrict arterioles, solutions of active principle, 1:1000 to 1:3000, are applied; the chloride is mostly used.
	*Adrenalin chloride						
107	*Epinephrine (alkaloid obtained from suprarenal glands)						
202 Plate vi	Æther, ethylic ether, 96%	N.	12	misc.	♏5–30	0.30–2	*Anesthetic; Local irritant: Stimulant* by reflex irritation; the spirits used for stimulating and anodyne effects.
	Spiritus ætheris, 32.5%	N.	...	...	fʒ¼–1	1–4	
220	*Spiritus ætheris compositus; Hoffman's anodyne	..	...	...	fʒ¼–1	1–4	
	*Æther, nitrous						
250 251	Spiritus ætheris nitrosi, sweet spirit of nitre	N.† or ac.	...	...	fʒ¼–1	1–4	*Diuretic; Diaphoretic:* In fevers and in nephritis.
165 208	Æthylis chloridum ethyl chloride	..	sl. sol.	v. s.	.....	.....	*Anesthetic; Analgesic:* Used locally as freezing agent.
	*Agaric, spunk (a fungus)	..	...	...	local use	.....	*Absorbent; Hemostatic.*
	Albolene; *see* Petrolatum						
	*Albumin	al.	sol.	insol.	Freely	.....	*Demulcent; Antidote;*
98 131 Plate viii	Alcohol, ethyl alcohol, 94.9% by vol.	N.	misc.	...	.....	.....	*Solvent; Preservative; Antiseptic:* Locally irritating to mucous membranes according to concentration; internally stimulant but in large doses is *sedative.*
98	Dehydratum, 99%	N.					
98	Dilutum, 49%	N.	...	...	fʒ1–8	4–30	
98	*Spiritus frumenti, whisky, 44–55%	N.	...	...	fʒ1–8	4–30	
98	*Spiritus vini gallici, brandy, 46–55%	N.	...	...	fʒ1–8	4–30	
100	*Alcohol, methyl, wood alcohol	N.	misc.	...	.....	.....	*Solvent; Antiseptic:* Not used internally; fumes have caused blindness. *Poison.*
Plate xviii	Aloe, aloes (inspissated juice of leaves)	..	sol. in boiling water	...	gr. 1–10	0.06–0.60	*Bitter tonic; Cathartic; Emmenagogue:* In habitual constipation; in hemorrhoids not due to active congestion; in amenorrhea, anemia, chlorosis.
	*Extractum aloes	..	...	...	gr. ½–3	0.03–0.20	
	Pilulæ aloes	..	...	...	1–4 pills		
	*Pilulæ a. et ferri	..	...	...	1–4 pills		
	Tinctura	..	...	...	fʒ¼–1	1–4	
Plate xviii	Aloinum, aloin (from aloes)	N.	65 v. s. in boiling water	sol.	gr. ¼–1	0.015–0.06	*Cathartic.*
102	Alumen, alum, aluminum and potass. sulphate or aluminum and ammonium sulphate	ac.	7.2	insol.	gr. 5–30	0.30–2	*Astringent:* Gargle or wash; to check superficial hemorrhage; large dose *emetic.*
80 103	Alumen exsiccatum, dried alum	ac.	20	insol.	local use	.....	*Astringent; Caustic:* Applied to excessive granulations.
220	*Ammonia, a gas	al.	sol.	sol.			
	Aqua ammoniæ, a 10% solution of the gas in water	al.	...	...	♏10–30	0.60–2	*Stimulant:* Inhaled in syncope; solvent.

† Spiritus ætheris nitrosi easily becomes acid, and is usually so as found in the stores.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol	Dose.	Dose. Gm. or mil.	Uses.
73 291	Aqua ammoniæ fortior, 28%	al.	...	...	.....	.....	Aq. ammoniæ fortior is *caustic.*
	Linimentum, 25%	..	...	...	.....	extern.	
	*Spiritus ammoniæ, 10%	al.	...	...	♏10–30	0.60–2	Internally as *stimulant.*
216 220	Spiritus ammoniæ aromaticus	al.	...	...	fʒ$\frac{1}{4}$–1	1–4	
	Liquor ammonii acetatis	ac.	...	...	f℥$\frac{1}{4}$–1	8–30	*Diaphoretic* in fevers.
	Ammonii benzoas	N.	10	35	gr. 5–30	0.30–2	Same as benzoic acid.
Plate xv	Ammonii bromidum	N.	1.3	12	gr. 5–30	0.30–2	*Sedative:* In epilepsy, whooping-cough.
220	Ammonii carbonas	al.	4	†	gr. 2–10	0.12–0.60	*Stimulant; Expectorant:* In pneumonia, typhoid conditions.
	Ammonii chloridum	N.	2.6	100	gr. 2–10	0.12–0.60	*Expectorant* in bronchitis; *alterative* in myalgia.
	Trochisci ammonii chloridi	..	...	...	1$\frac{1}{2}$ gr. in each		
	Ammonii iodidum	N.	0.6	3.7	gr. 2–10	0.12–0.60	*Alterative* in syphilis, scrofula.
	*Ammonii nitras	N.	0.5	20	.....	.....	To prepare nitrous oxide.
	Ammonii valeras	ac.	v. s.	v. s.	gr. 5–15	0.30–1	*Stimulant* in hysteria
	*Amygdala amara, bitter almond seeds	..	...	...	.....	.....	*Nerve sedative* in cough and vomiting; the preparations of bitter almond contain hydrocyanic acid in small amount.
	Oleum amygdalæ amaræ	N.	300	sol.	♏$\frac{1}{6}$–$\frac{1}{2}$	0.01–0.03	
	Spiritus, 1% oil	N.	...	...	♏5–10	0.30–0.60	
	Amygdala dulcis, sweet almond seeds						
	Emulsion amygdalæ	..	...	...	Freely	.....	As vehicle.
	Oleum amygdalæ expressum	..	...	...	fʒ1–4	4–15	*Demulcent.*
225 Plate xiii 294	Amylis nitris, nitrite of amyl	N.	insol.	misc.	♏1–5	0.06–0.30	Inhaled in angina pectoris, asthma, hiccough, epilepsy.
	Amylum, starch	..	...	...	.....	.....	*Demulcent:* Dusting powder.
	Glyceritum amyli	..	...	...	Freely	.....	*Demulcent.*
	*Anesthesin	..	...	...	.....	.....	*Local analgesic.*
	Animal charcoal; *see* Carbo						
	Anisum, anise seed	..	...	...	gr. 10–30	0.60–2	*Aromatic, Carminative:* In colic.
	Aqua anisi	N.	...	...	f℥$\frac{1}{4}$–1	8–30	
	Oleum	N.	...	1	♏1–5	0.06–0.30	Flavoring agent.
	Spiritus	..	...	...	fʒ$\frac{1}{4}$–1	1–4	
251	Antimonii et potassii tartras, tartar emetic	sl. ac.	12	insol.	gr. $\frac{1}{2}$–2 gr. $^{1}/_{12}$–1	0.03–0.12 0.005	*Emetic.* *Sedative; Expectorant:* Depresses heart.
	*Vinum antimonii	..	...	...	♏5–60	0.30–4	*Expectorant.*
107 240	Antipyrina, phenazone	N.	1	1.3	gr. 2–10	0.12–0.60	*Antipyretic* in acute fevers; *anodyne* in neuralgias, migraine, myalgia, pertussis, infantileconvulsions; *hemostatic* locally to check capillary hemorrhages.
	*Antiseptol; *see* cinchonine iodosulphate						
54	*Antitoxin, a serum that is antidotal to the toxin of a certain disease; as an example, *see* Serum antidiphthericum						
252	Apomorphinæ hydrochloridum (from morphine)	N.	40	50	gr. $^{1}/_{20}$–$^{1}/_{10}$	0.003–0.006	*Emetic:* Hypodermically when patient cannot swallow, as in opium narcosis.
148	*Argentum, silver, a metal						Silver salts are *astringent* and *antiseptic;* a form of metallic silver soluble in water, also citrate, lactate and nitrate are used as *antiseptics;* nitrate as *astringent;* in chronic dysentery; diarrhea of typhoid fever; to check caries in temporary teeth; also as *caustic;* locally to abort inflammation.
149	*Argenti citras, itrol	..	sl. sol.	...	extern.		
149	*Argenti lactas, actol	..	20	...	extern.		
78 103 148	Argenti nitras	N.	0.4	30	gr. $\frac{1}{6}$–$\frac{1}{2}$	0.01–0.03	
78	*Argenti nitras dilutus, mitigated caustic, 33$\frac{1}{3}$%	N.	sol.	sol.			
78	Argenti nitras fusus, lunar caustic, 96%	N.	sol.	sol.			

† Decomposition occurs.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol	Dose.	Dose. Gm. or mil.	Uses.
	Argenti oxidum	al.	sl. sol.	insol.	gr. ½–2	0.03–0.12	In nervous diseases.
	Aristol; *see* Thymolis iodidum						
	Arnica (flowers)						
	Tinctura arnicæ	..	...	...	♏15–45	1–3	As a liniment.
82 232	Arseni trioxidum, arsenic	sl. ac.	{ 30 / 100 }	sl. sol.	gr. 1/60–1/10	0.001–0.006	*Escharotic:* has slow but powerful action;
291	Liquor acidi arsenosi, 1%	ac.	...	...	♏2–10	0.12–0.60	to devitalize pulps of teeth; in small
232	Liquor potassii arsenitis, Fowler's sol.	al.	...	...	♏2–10	0.12–0.60	doses *alterative tonic;* to improve the nu-
	Liquor sodii arsenatis, 1%	N.	...	...	♏2–10	0.12–0.60	trition in anemia, chorea, chronic dis-
	(Pearson's sol. 1/10 as strong as above)						eases of the skin; *antiperiodic* in malarial fever.
232	Liquor arseni et hydrargyri iodidi, Donovan's solution	..	...	...	♏2–8	0.12–0.50	Donovan's solution as a combination of alteratives is used in
	*Solution of potassium arsenate and bromide, Clemen's solution	..	...	...	♏2–10	0.12–0.60	syphilitic and tuberculous (scrofulous) conditions; sod. cacodylate and arsani-
	Arseni iodidum	N.	12	28	gr. 1/30–1/10	0.002–0.006	late are less toxic
	Sodii arsenas	N. or al	12	sl. sol.	gr. 1/30–1/10	0.002–0.006	salts of arsenic; sal-
	Salvarsan	N.	10	12	gr. 1–8	0.06–0.50	varsan is largely
	Neosalvarsan	N.	v. s.	...	gr. 2–10	0.12–0.60	used in early stages
	Sodium arsanilate, atoxyl	..	6	...	gr. 8	0.5	of syphilis.
	Sodii arsenas exsiccatus	al.	3.1	sl. sol.	gr. 1/60–1/10	0.001–0.006	
	Sodii cacodylas	..	5	2.5	gr. ½–3	0.03–0.20	
	Asafetida; a gum-resin	..	part	part	gr. 1–8	0.06–0.50	*Stimulant; Laxative:* As antispasmodic in
	Emulsum asafetidæ, milk of asafetida	..	...	...	f℥½–1	15–30	hysteria, chorea and other nervous spas-
	Pilulæ asafetidæ	..	...	...	3 gr. in each		modic conditions; in flatulent colic.
	Tinctura	..	...	...	fʒ½–1	2–4	
	*Aseptol, a 33⅓% solution of orthophenolsulphonic acid	..	sol.	sol.	.....	.....	*Antiseptic:* Locally in dilute solution.
	Aspidium, male fern (root)	..	...	...	ʒ½–2	2–8	*Anthelmintic:* To destroy tapeworm.
	Oleoresina aspidii	..	...	...	fʒ¼–½	1–2	
	Aspirin; *see* Acid, acetylsalicylic						
Plate ix 222	Atropina, from belladonna	al.	455	2	gr. 1/120–1/60	.0005–0.001	*Stimulant; Mydriatic:* To dilate pupil and
291	Atropinæ sulphas	N.	0.4	5	gr. 1/120–1/60	.0005–0.001	paralyze accommodation; to relieve
	Homatropinæ hydrobromidum	N.	6	40	gr. 1/120–1/60	.0005–0.001	peripheral irritation, cough, asthma, etc.; as respiratory stimulant in opium poisoning; homatropine is a more transient mydriatic.
	Aurantii amari cortex, bitter orange-peel	..	...	...	.....	.....	*Bitter tonic:* Carminative; preparations used chiefly as vehicles.
	Fluidextractum aurantii amari	..	...	...	fʒ¼–½	1–2	
	Tinctura	..	...	...	fʒ1–2	4–8	
	Aurantii dulcis cortex, sweet orange-peel	..	...	...	.....	.....	Preparations as flavoring agents and vehicles.
	Oleum aurantii	N.	insol.	4	♏1–5	0.06–0.30	*Flavoring agent.*
	Syrupus aurantii Spiritus a. comp. Tinctura a. dulcis	..	...	...	Freely	.....	As vehicles.
	*Aurantii flores, orange flowers Aqua aur. florum Aqua a. fl. fortior	..	...	...	.....	.....	*Flavoring agents.*
	Syrupus a. florum	..	...	...	.....	.....	As vehicle.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	*Oleum a. florum, oil of neroli	N.	insol.	1	.....	.....	*Perfume.*
	*Aurum, gold						
	Auri et sodii chloridum	sl. ac.	v. s.	part	gr. 1/30–1/10	0.002–0.006	*Alterative:* In syphilis, action similar to bichloride of mercury; in sclerosis of liver and kidneys, impotence, amenorrhea, nervous disorders, diabetes; the bromide in epilepsy; the chloride recommended in tuberculous disorders.
	*Aurum bromide	..	...	...	gr. 1/100–1/10	0.0006–0.006	
	*Aurum chloride	..	sol.	sol.	gr. 1/60–1/30	0.001–0.002	
	*Solution of gold and arsenic bromide, "arsenauro"	..	...	...	♏5–15	0.30–1	
	*Solution of gold, arsenic and mercury bromide "mercauro"	..	...	...	♏5–15	0.30–1	
	Balsam of copaiba; *see* Copaiba						
134	Balsamum Peruvianum	ac.	...	5	extern.	.....	In scabies.
	Balsamum tolutanum	ac.	...	sol.	♏10–30	0.60–2	*Stimulant; expectorant.*
	Syrupus tolutanus	..	...	...	f℥¼–1	8–30	As vehicle.
	Tinctura tolutana	..	...	...	fʒ½–1	2–4	As vehicle.
	Basham's mixture; *see* under Ferrum						
	Bearberry; *see* Uva ursi						
222 Plate ix	Belladonnæ folia, deadly night-shade (leaves)	..	...	...	gr. 1–2	0.06–0.12	*Mydriatic:* Atropine to dilate pupil.
291	Extractum belladonnæ foliorum	..	...	...	gr. ⅛–½	0.0075–0.03	*Anodyne:* To quiet peripheral pain and irritation; in asthma, nervous cough, irritable bladder, incontinence of urine; combined with cathartics to prevent griping; in small doses *stimulant* to the heart and respiration; in opium poisoning; *vasomotor stimulant;* to check sweating.
	Emplastrum	..	...	...	extern.		
	Tinctura belladonnæ foliorum	..	...	...	♏5–15	0.30–1	
	Unguentum belladonnæ;	..	...	...	extern.		
	Belladonnæ radix (root)	..	...	...	gr. 1–2	0.06–0.12	
	Fluidextractum belladonnæ radicis	..	...	...	♏1–2	0.06–0.12	
	Linimentum belladonnæ; *see* Atropine	..	...	...	extern.		
	Benzinum (from petroleum)	N.	insol.	6	.....	.....	*Solvent.*
133	Benzoinum	..	...	...	gr. 5–30	0.30–2	To prepare benzoic acid; *Antiseptic.* Tinctures inhaled in respiratory diseases and applied as local stimulants and antiseptics to mucous membranes.
	Tinctura benzoini	..	...	...	♏5–60	0.30–4	
	Tinctura benzoini composita, Friar's balsam	..	...	...	♏5–60	0.30–4	
	*Benzol (from coal-tar)	..	...	sol.	.....	.....	*Solvent.*
	*Benzosol, guaiacol benzoate	..	insol.	...	gr. 2–10	0.12–0.60	*Antiseptic:* In intestinal diseases and phthisis.
266 285	Benzosulphinidum, saccharin (a coal-tar product)	ac.	290	31	gr. 1–5	0.06–0.30	*Sweetening agent:* Is 500 times sweeter than cane-sugar.
145	Betanaphtol, naphtol	N.	1000	0.8	gr. 2–10	0.12–0.60	*Antiseptic.*
179 182	Betaeucainæ hydrochloridum, eucaine	N.	30	35	gr. ¼–½	0.015–0.03	*Local analgesic:* Less powerful and toxic but more irritating, than cocaine.
	*Bismuth; a metal						
	Bismuthi subcarbonas	..	insol.	insol.	gr. 5–20	0.30–1.30	Locally *sedative* and slightly astringent; in vomiting, diarrhea, gastric ulcer.
	Bismuthi subnitras	sl. ac.	insol.	insol.	gr. 5–20	0.30–1.30	
	Magma bismuthi, milk of bismuth	N.	...	...	fʒ½–2	2–8	
	*Bismuth oxyiodide (subiodide)	..	insol.	insol.	gr. 5–10	0.30–0.60	*Antiseptic* to dress wounds and ulcers.
	Bismuthi subgallas, dermatol	..	insol.	insol.	gr. 5–15	0.30–1	*Antiseptic:* As substitute for iodoform; also internally.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	*Bismuth tribromphenolate, xeroform	..	insol.	insol.	extern.	.....	*Antiseptic:* Has been used in root filling.
	Bisulphide of carbon; *see* Carbonei disulphidum						
	Bitter almond; *see* Amygdala amara						
	Bitter orange peel; *see* Aurantii						
	Blackberry; *see* Rubus						
	Black haw; *see* Viburnum prunifolium						
	Black wash, Blue ointment, Blue pill; *see* under Hydrargyrum						
	Borax; *see* Sodii boras						
	Brandy; *see* under Alcohol						
	Bromoformum	..	300	sol.	♏1–5	0.06–0.30	*Anesthetic:* recommended in pertussis.
142, 291	Bromum, bromine	..	28	sol.	extern.	.....	*Caustic; Reagent; Antiseptic.*
	Brown mixture; *see* under Glycyrrhiza						
251	Buchu (leaves)	..	...	...	gr. 15–60	1–4	*Stimulant; diuretic;* in inflammation of the genito-urinary tract.
	Fluidextractum buchu	..	...	...	♏15–60	1–4	
	Buckthorn; *see* Frangula						
	Cacao butter; *see* under Theobroma						
	*Caffea (C. arabica), coffee (seeds)	..	...	...	.....	.....	*Stimulant; Diuretic;* Stimulates cerebrum and heart; in opium poisoning strong infusion or decoction by enema or caffeine hypodermically; in headaches, cardiac failure.
177, 216	Caffeina, caffeine (theine)	N.	46	66	gr. 1–5	0.06–0.30	
223, Plate x	Caffeina citrata, 50% caffeine	ac.	sol.	sol.	gr. 2–10	0.12–0.60	
	Caffeina citrata effervescens, 2% caffeine	..	sol.	sol.	ʒ½–2	2–8	
117, 223	Caffeinæ sodiobenzoas	..	1.1	30	gr. 2–10	0.12–0.60	
	Cajuput, oil of; *see* Oleum cajuputi						
	Calcium; *see* under Calx						
	Calomel; *see* under Hydrargyrum						
227	Calumba (Jateorhiza palmata), columbo (root)	..	...	...	gr. 5–30	0.30–2	*Bitter tonic:* In atonic indigestion; *it contains no tannin.*
	Tinctura	..	...	...	fʒ1–2	4–8	
	Calx, lime	al.	840 part	insol. part	.....	.....	*Caustic.*
142, 160	Calx chlorinata, bleaching powder, chloride of lime	al.			.....	.....	*Disinfectant.*
	Calcii sulphidum crudum	al.	sl. sol.	insol.	gr. 1/10–1	0.006–0.06	To prevent suppuration.
90	Linimentum calcis, carron oil	..	...	...	.....	.....	Externally to burns.
119	Liquor calcis, limewater	al.	...	...	fʒ1–8	4–30	*Alkali:* In vomiting, diarrhea; to correct acidity and irritability of stomach; *antidote* to oxalic acid.
	*Syrupus calcis	al.	...	...	♏15–60	1–4	
	*Calcium, a metal						
	Calcii bromidum	N. or al.	0.7	1.3	gr. 5–30	0.30–2	*Sedative:* Same use as sodium bromide.
121	Carbonate. Calcii carbonas præcipitatus; Cretæ præparata, prepared chalk	al.	alm. insol.	insol.	gr. 5–30	0.30–2	Preparations of the carbonate are used in indigestion, vomiting, and diarrhea; prepared chalk as an antacid to the mouth and in dentifrices.
	Mistura cretæ	..	...	...	fʒ2–8	8–30	
	Pulvis cretæ compositus	..	...	...	gr. 5–60	0.30–4	

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol	Dose.	Dose. Gm. or mil.	Uses.
111	Calcii chloridum	N.	1.2	10	gr. 5–10	0.30–0.60	*Alterative: Hemostatic:* Chloride and lactate internally in hemorrhages.
	Calcii lactas	..	20	alm. insol.	gr. 5–10	0.30–0.60	
	Calcii hypophosphis	N.	6.5	insol.	gr. 2–10	0.12–0.60	*Tonic; Alterative:* In anemia, rhachitis, caries.
	*Syrup	..	...	...	fʒ1–3	4–12	
231	Syrupus hypophosphitum	..	...	...	fʒ1–3	4–12	Syrups of hypophosphites in wasting diseases, tuberculosis, rhachitis, nervous diseases.
231	*Syrupus hypophosphitum compositus	..	...	...	fʒ1–3	4–12	
	Syrupus calcii lactophosphatis	..	...	...	fʒ1–3	4–12	Similar uses to above.
	*Calcii sulphas exsiccatus, plaster of Paris	N.	378	insol.	.....	.....	Used in making impressions, casts and plaster-of-Paris bandages and jackets.
	*Calcium iodide	..	0.5	...	gr. 2–4	0.12–0.25	*Alterative; Antiseptic:* In pulmonary syphilis.
	Cambogia, Gamboge	..	...	...	gr. 1–3	0.06–0.20	*Cathartic:* In dropsies.
221 292	Camphora, camphor	..	sl. sol.	sol.	gr. 1–5	0.06–0.30	*Stimulant; Anodyne:* To relieve spasm or cramp, dysmenorrhea, cholera, colic, diarrhea, nervous depression, headache, neuralgia; spirit inhaled in syncope; liniment externally;
	Aqua camphoræ	..	...	...	fʒ1–4	4–15	
	*Ceratum	..	...	...	.....	extern.	
221	Spiritus, 10%	..	...	...	fʒ¼–½	1–2	
	Linimentum camphoræ, camphorated oil, 20%						
	*Acid camphor mixture, Hope's mixture	..	...	...	fʒ1–4	4–15	in diarrhea.
	Camphora monobromata	N.	alm. insol.	6.5	gr. 1–5	0.06–0.30	Monobromate is *sedative* to nervous system; in insomnia and hysteria.
292	Cannabis; C. sativa or indica, Indian hemp (tops of female plant)	..	...	...	gr. 2–5	0.12–0.30	*Anodyne; Deliriant; Hypnotic:* In migraine, neuralgia, dysmenorrhea, irritable bladder, retention of urine; in tetanus, delirium tremens, acute mania.
	Extractum cannabis	..	...	...	gr. ⅙–½	0.01–0.03	
	Fluidextractum	..	...	...	♏1–4	0.06–0.25	
	Tinctura	..	...	...	♏5–20	0.30–1.20	
67 292	Cantharis, Spanish flies	..	...	...	.....	.....	*Vesicant:* To produce blister in neuralgia, rheumatism; counteract local inflammations; promote absorption of effusions.
	Ceratum cantharidis Collodium cantharidatum	..	...	...	.....	extern.	
	Tinctura cantharidis	..	...	...	♏1–4	0.06–0.25	Tincture internally is *diuretic* and *irritant;* use cautiously; applied locally diluted, to stimulate growth of hair.
61	Capsicum (C. frutescens), Cayenne pepper (fruit)	..	...	...	gr. 1–3	0.06–0.20	*Local stimulant* and *irritant:* To stimulate unhealthy condition of the gums; in atony of stomach, diarrhea, colic, indigestion of alcoholism; plaster as mild counterirritant.
	Emplastrum	..	...	...	.....	extern.	
	Oleoresina	..	...	...	♏¼–1	0.015–0.06	
	Tinctura	..	...	...	♏5–10	0.30–0.60	
152	*Carbo animalis, animal charcoal	..	...	...	.....	.....	*Decolorizing agent.*
	*Carbo animalis purificatus	..	...	...	Freely	.....	As *antidote* in alkaloidal poisoning; to decolorize and purify liquids.
152	Carbo ligni, wood charcoal	..	...	...	Freely	.....	*Absorbent:* Internally in flatulent indigestion.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	Carbonei disulphidum	N.	526	v. s.	.....	.....	*Solvent* for rubber.
	Cardamomum, cardamon (seed)	..	...	...	gr. 10–15	0.60–1	*Aromatic:* As flavoring agent and carminative; in flatulent colic.
	Tinctura cardamomi	..	...	...	fʒ¼–1	1–4	
	Tinctura c. comp.	..	...	...	fʒ½–2	2–8	
	*Carmine, carminic acid (from coccus)	..	sol.	sol.	.....	.....	*Coloring agent.*
	Carron oil; *see* under Calx						
	Caryophyllus (eugenia aromatica), cloves (flower buds)	..	...	...	gr. 2–10	0.12–0.60	*Aromatic:* As condiment and *carminative;* the oil in preparing microscopic specimens.
139	Oleum caryophylli	..	insol.	sol.	♏1–5	0.06–0.30	
Plate xviii	Cascara sagrada, rhamnus purshiana (bark)	..	...	...	ʒ¼–1	1–4	*Tonic cathartic;* in chronic constipation.
	Extractum cascaræ sagradæ	..	...	...	gr. 1–5	0.06–0.30	
	Fluidextractum	..	...	...	♏10–30	0.60–2	
	Fluidextract, arom.	..	...	...	♏15–60	1–4	
	Cassia, oil of; *see* under Cinnamomum						
	Castor oil; *see* Oleum ricini						
	Catechu; *see* Gambir						
	Cera alba, white wax	..	insol.	spar.			In cerates and ointments; as impression and modelling material.
	Ceratum				extern.	.....	
	Cera flava, yellow wax	..	insol.	spar.			
	Cetaceum, spermaceti	N.	insol.	alm. insol.	extern.	.....	In cerates and ointments.
	Chalk, prepared; *see* under Calcium						
	Charcoal; *see* Carbo.						
156	*Chinosol, quinosol	..	v. s.	insol.	.....	.....	*Antiseptic:* For treating pus cavities (1 to 2% sol.); internally as intestinal antiseptic.
245 246 Plate xvi 292	Chloralum hydratum, chloral	N.	0.25	1.3	gr. 5–15	0.30–1	*Hypnotic; Sedative:* In insomnia, mania, tetanus, convulsions of children, strychnine poisoning, epilepsy, other spasmodic affections, delirium of fevers, cholera; use cautiously.
	*Butyl-chloral, croton-chloral	..	...	...	gr. 5–15	0.30–1	Croton-chloral, similar to chloral in action, is said to have a special anodyne effect upon the fifth cranial nerve.
	*Chloral-camphor	..	insol.	sol.			Locally in neuralgia as *anodyne* and *counterirritant.*
	*Chloral-phenol	..	sol.	sol.	extern.	.....	
	*Chloral-menthol	..	...	sol.			
	*Chloretone, acetone-chloroform	..	125	v. s.	gr. 5–15	0.30–1	*Hypnotic; Analgesic.*
	Chloride of lime; *see* Calx chlorinata						
142	*Chlorine; a gas						
142 160	Liquor sodæ chlorinatæ, Labarraque's solution, 2.5% chlorine	al.	...	...	fʒ½–1	2–4	*Antiseptic:* Externally as disinfectant wash; *bleaching agent:* to bleach discolored teeth.
142 160	Calx chlorinata, chloride of lime, 30% chlorine	al.	part.	part.	.....	.....	*Disinfectant; Bleaching agent.*

Page in text.	Drug.	Reac-tion.	Solubility in Water.	Solubility in Alcohol	Dose.	Dose. Gm. or mil.	Uses.
205	Chloroformum	N.	210	sol.	♏2–10	0.12–0.60	*Anesthetic; Anodyne:* By inhalation mostly; in convulsions, dysmenorrhea and other spasmodic pain; locally as *anodyne* and *irritant;* internally in colic.
Plate vii	Aqua chloroformi, about 0.5%	..	...	...	f℥¼–1	8–30	
67	Linimentum, 30%	..	...	...	.....	extern.	
292	Spiritus, 6% A stronger spirit (⅓ chloroform) is known as chloric ether	..	...	...	fʒ½–2	2–8	
80	Chromii trioxidum, chromic acid	ac.	0.6	†	.....	.....	*Caustic:* Local use only.
227	Cinchona, Peruvian bark	..	...	...	gr. 10–30	0.60–2	*Bitter astringent tonic:* in atonic indigestion, relaxed conditions of mucous membrane of digestive tract; general tonic; *antiperiodic;* in malarial fevers, periodic neuralgia.
	Cinchona rubra	..	...	...	gr. 10–30	0.60–2	
	Fluidextractum cinchonæ	..	...	...	♏10–30	0.60–2	
	Tinctura	..	...	...	fʒ½–2	2–8	
	Tinctura cinchonæ composita; *see* Quinina	..	...	...	fʒ½–2	2–8	
	Cinchonidinæ sulphas	N.	63	72	gr. 1–20	0.06–1.30	The alkaloids possess the *tonic* and *antimalarial* virtues of cinchona; in medicinal value they stand in the following order:
	Cinchoninæ sulphas	N.	58	10	gr. 1–20	0.06–1.30	Quinine. Cinchonidine. Cinchonine.
143	*Cinchonine iodosulphate, antiseptol	..	insol.	...	extern.	.....	*Antiseptic:* An odorless substitute for iodoform (50% iodine).
	Cinnamomum, cinnamon (bark) *C. cassia C. saigonicum C. zeylanicum	..	...	...	gr. 1–10	0.06–0.60	*Aromatic; Condiment.*
	Aqua cinnamomi	..	...	...	f℥¼–1	8–30	As vehicle.
138	Oleum cassiæ, oil of cinnamomi	sl. ac.	insol.	sol.	♏1–5	0.06–0.30	*Flavoring agent:* Used as carminative in flatulence; *antiseptic;* spirit and tincture as vehicle.
	Spiritus	..	...	...	♏10–60	0.60–2	
	Tinctura	..	...	...	♏5–30	0.30–2	
	Cloves; *see* Caryophyllus						
88	*Cobalt	..	...	...	extern.	.....	*Escharotic:* To devitalize pulps of teeth.
169 Plates ii, iii	*Coca, erythroxylon coca (leaves)	..	...	...	ʒ¼–1	1–4	*Stimulant:* In action similar to coffee; large doses are *sedative;* the alkaloid cocaine is a *local analgesic, stimulant* and *mydriatic;* locally or hypodermically in 1 to 4% aqueous solution to abolish sensation; applied to the eye it dilates pupil; use cautiously to avoid poisoning or habit.
	Cocaina (from erythroxylon coca and its varieties)	al.	600	6.5			
169 292 Plates ii, iii	Cocainæ hydrochloridum	N.	0.4	3.2	gr. ⅙–½	0.01–0.03	
	*Oleatum cocainæ, 5%	..	...	...	locally		
	Coccus, cochineal (an insect); used as coloring agent; *see* also Carmine						
248 294	Codeina (alkaloid from opium)	al.	120	2	gr. ¼–1	0.015–0.06	Same use as opium; The after-effects are less unpleasant; in diabetes.
	Codeinæ phosphas	ac.	2.3	325	gr. ¼–1	0.015–0.06	
	Codeinæ sulphas	N.	30	1280	gr. ¼–1	0.015–0.06	
	Cod-liver oil; *see* Oleum morrhuæ						
	Coffee; *see* Caffea						
	Colchici cormus (corm of colchicum autumnale)	..	...	...	gr. 2–10	0.12–0.60	*Alterative:* In full doses *diuretic* and *cathartic;* its chief use is in subacute or chronic rheumatism and in rheumatic gout; in ascites due to hepatic obstruction; colchicine may be given hypodermically.
	Extractum colchici cormi	..	...	...	gr. ½–2	0.03–0.12	
	Colchici semen (seed)	..	...	...	gr. 1–8	0.06–0.50	
	Fluidextractum colchici seminis	..	...	...	♏1–8	0.06–0.50	
	Tinctura colchici seminis	..	...	...	♏10–60	0.60–4	
	Colchicina (alkaloid from c. autumnale)	N.	22	v. s.	gr. 1/120	0.0005	
	Cold cream; *see* under Rosa						

† Decomposition occurs.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
114	Collodium, collodion	..	...	...	extern.	.....	Protective to slight wounds and to check superficial hemorrhages.
114	Collodium flexile, flexible collodion						
67	Collodium cantharidatum	..	...	...	extern.	.....	*Vesicant:* For blistering purposes.
114	*Collodium stypticum, 20% tannic acid	..	...	...	extern.	.....	*Styptic.*
Plate xviii	Colocynthis (citrullus c., fruit)	..	...	...	gr. 1–3	0.06–0.20	*Tonic cathartic:* In constipation; in full doses powerful *hydragogue cathartic;* in dropsies; given usually in combination.
	Extractum colocynthidis	..	...	...	gr. $\frac{1}{4}$–1	0.015–0.06	
	Extractum c. compositum	..	...	...	gr. 5–15	0.30–1	
	Pilulæ catharticæ compositæ†	..	...	...	1–3 pills		
	*Pilulæ catharticæ vegetabiles	..	...	...	1–5 pills		
	Columbo; *see* Calumba						
	*Convallaria (c. majalis); lily of the valley (root)	..	...	...	gr. 5–30	0.30–2	*Heart stimulant; Diuretic:* Similar to digitalis in action; in large doses *cathartic.*
	*Fluidextractum convallariæ	..	...	...	♏5–30	0.30–2	
	Copaiba, balsam of copaiba	..	...	...	fʒ$\frac{1}{4}$–1	1–4	*Diuretic; Expectorant:* In later stages of gonorrhea; chronic cystitis and chronic bronchitis.
	*Oleum copaibæ	..	...	...	♏5–15	0.30–1	
	Copperas; *see* Ferri sulphas						
	Copper salts; *see* under Cuprum						
	Corrosive sublimate; *see* under Hydrargyrum						
110	Cotarninæ hydrochloridum (from narcotine, an opium alkaloid)	N.	v. s.	v. s.	gr. $\frac{1}{2}$–3	0.03–0.20	*Hemostatic:* In hemorrhage from small vessels.
	Cotton; *see* Gossypium						
	Cotton-seed oil; *see* under Gossypium						
	Cream of tartar; *see* Potassii bitartras						
130	Creosotum (distilled from wood)	N. or ac.	140	sol.	♏1–8	0.06–0.50	*Antiseptic:* In aqueous solution as mouth-wash; to check fermentation within the digestive tract; in vomiting, flatulence and fermentative diarrhea; internally in phthisis and other pulmonary diseases; *guaiacol* and its salts have similar uses.
131	Aqua creosoti, 1%	..	...	...	fʒ1–4	4–15	
131	Guaiacol	..	53	sol.	♏2–15	0.12–1	
	Guaiacolis carbonas	..	insol.	60	gr. 5–30	0.30–2	
	Creosoti carbonas	N.	insol.	sol.	♏5–30	0.30–2	
	*Creolin (from coal tar	..	misc.	sol.	♏1–5	0.06–0.30	*Antiseptic:* Valuable for general use as douche; in cystitis, intestinal disorders.
129	Cresol (from coal tar)	..	50	misc.	♏$\frac{1}{2}$–2	0.03–0.12	*Antiseptic.*
	Liquor cresolis, comp. lysol	..	...	...	.....	extern.	
	Creta præparata; *see* under Calcium						
	Croton oil; *see* Oleum tiglii						
91	Cubeba (Piper c., unripe fruit)	..	...	...	ʒ$\frac{1}{4}$–$\frac{1}{2}$	1–2	*Aromatic stimulant; diuretic; Expectorant:* In bronchitis, pharyngitis and laryngitis; chronic inflammations of genito-urinary tract.
251							
252	Fluidextractum cubebæ	..	...	...	fʒ$\frac{1}{4}$–$\frac{1}{2}$	1–2	
	Oleoresina	..	...	...	♏5–15	0.30–1	
	Oleum	N.	insol.	sol.	♏5–15	0.30–1	
	Trochisci	..	...	...	gr. $\frac{1}{3}$ of oleoresin in each		

† 1 grain of calomel in each.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
80	*Cuprum, copper						
104	Cupri sulphas	ac.	2.5	500	gr. ½–5	0.03–0.30	In full dose *emetic;* locally *astringent* and *irritant;* to stimulate indolent ulcers; as a mild *caustic* applied to granular eyelids.
	Deadly nightshade; *see* Belladonna						
	Dermatol; *see* under Bismuthum						
	Diacetylmorphina, heroin	al.	1700	31	gr. 1/30–1/10	0.002–0.006	*Sedative:* In cough mixtures; being more powerful than morphine, it must be used with caution.
	Diacetylmorphinæ hydrochloridum	N.	2	sol.	gr. 1/30–1/10	0.002–0.006	
	Diachylon ointment; *see* under Plumbum						
177, 224	Digitalis (d. purpurea, leaves)	..	...	...	gr. ½–2	0.03–0.12	*Heart stimulant* and *tonic; Diuretic;* Strengthens and slows heart beats; in weak circulation due to heart dilatation or exhaustion.
250	Fluidextractum	..	...	...	♏½–2	0.03–0.12	
Plate	Infusum	..	...	...	fʒ1–4	4–15	
xii	Tinctura, 10%	..	...	...	♏5–20	0.30–1.20	
Plate iv							
	*Digitalin	..	...	...	gr. 1/60–1/30	0.001–0.002	A product of uncertain and variable character.
	Diuretin; *see* under Theobroma						
	Dobell's solution; *see* under Sodii boras						
	Donovan's solution; *see* under Arseni trioxid						
	Dover's powder; *see* under Opium						
Plate xviii	Elaterinum (from elaterium)	N.	insol.	325	gr. 1/20–1/10	0.003–0.006	*Hydragogue cathartic:* In dropsies, cerebral hyperemia threatening apoplexy.
293	Trituratio elaterini, 10%	..	...	...	gr. ½–1	0.03–0.06	
	Emetinæ hydrochloridum (alkaloid of ipecacuanha)	sl. ac.	v. s.	v. s.	gr. ⅓	0.02	*Emetic:* May be used hypodermically; recommended in pyorrhea.
107	Epinephrine; the active principle of suprarenal glands; *see* Suprarenalum siccum						
	Epsom salt; *see* Magnesii sulphas						
108	Ergota, ergot of rye	..	...	...	.....	.....	*Oxytocic; Vasoconstrictor:* To stimulate contraction of uterus after labor; to check capillary hemorrhages, menorrhagia, diarrheas; to reduce cerebral and spinal hyperemia.
Plate i	Extractum ergotæ, "ergotin"	..	...	...	gr. 2–8	0.12–0.5	
	Fluidextractum	..	...	...	fʒ¼–1	1–4	
	Eriodictyon, yerba santa (e. californicum, leaves)						
	Fluidextractum eriodictyi	..	...	...	♏15–30	1–2	*Stimulant expectorant:* In chronic pulmonary diseases; in syrup to cover bitter taste of quinine.
	Eserine; *see* under Physostigma						
	Ether, chloric; *see* under Chloroform						
	Ether, ethylic; *see* Æther						
212	*Ethyl bromide, hydrobromic ether	..	spar.	sol.	.....	inhaled	*Anesthetic:* Prompt in action, but dangerous.
	Ethyl chloride; *see* Æthylis chloridum						
	*Ethyl iodide, hydriodic ether	..	insol.	sol.	.....	inhaled	*Anesthetic; Alterative; Stimulant.*
	*Ethylene bichloride, Dutch liquid	..	...	...	.....	inhaled	*Anesthetic:* Probably ranks between ether and chloroform in safety.
	*Ethylidene chloride	..	...	...	.....	inhaled	*Anesthetic:* Probably less depressing than chloroform.

Page in text.	Drug.	Reaction.	Solubility in		Dose.		Uses.
			Water.	Alcohol.		Gm. or mil.	
Plate xviii	Frangula (rhamnus f.), buckthorn (bark)	..	...	...	.....	.....	*Cathartic:* Fresh bark is harsh, old bark is mild and efficient; in chronic constipation.
	Fluidextractum frangulæ	..	...	...	fʒ¼–1	1–4	
	Friar's balsam; *see* under Benzoin						
97	Galla, nutgall (from quercus infectoria)	..	...	...	.....	.....	*Astringent:* Virtues due to the tannic and gallic acids contained.
	Unguentum	..	...	...	.....	extern.	
97	Gambir, catechu	..	part.	sol.	gr. 10–30	0.60–2	*Astringent:* Owes its value to tannic acid.
	Tinctura gambir composita	..	...	...	fʒ½–2	2–8	
	Gamboge; *see* Cambogia						
	*Gaultheria, wintergreen (leaves)	..	...	...	ʒ½–2	2–8	*Aromatic; Astringent:* Substitute for salicylic acid in rheumatism; used as *flavoring agent.*
137 140	Oleum gaultheriæ, methyl salicylate	N. or sl. ac.	spar.	sol.	♏1–10	0.06–0.60	
	*Spiritus	..	...	...	fʒ1–2	4–8	
111	Gelatinum	..	...	...	.....	.....	To prepare capsules and suppositories; as coating for pills; in hemophilia by rectum or subcutaneously.
29	Gelatinum glycerinatum						
227	Gentiana (g. lutea, root)	..	...	...	.....	.....	*Bitter tonic:* Simple stomachic and general tonic; *contains no tannin.*
	Extractum gentianæ	..	...	...	gr. 2–10	0.12–0.60	
	Fluidextractum	..	...	...	♏5–30	0.30–2	
	Tinctura comp.	..	...	...	fʒ½–2	2–8	
	Ginger; *see* Zingiber						
	Glauber's salt; *see* Sodii sulphas						
	Glonoin; *see* Nitroglycerin						
92 265	Glycerinum, glycerol	N.	v. s.	v. s.	♏5–60	0.30–4	*Vehicle; Solvent; Preservative:* Locally *demulcent* and *emollient;* in enema or suppository for constipation; sweetening agent.
29	Suppositoria glycerini	N.	...	...	.....	.....	*Laxative:* For introduction into the rectum.
91	Glycyrrhiza (g. glabra), licorice root	..	...	...	.....	.....	*Expectorant: Demulcent:* In cough mixtures; to cover taste of bitter drugs.
	Elixir glycyrrhizæ	..	...	...	.....	freely	*Vehicle.*
	Extractum	..	...	...	.....	freely	
	Extractum purum	..	...	...	.....	freely	
	Fluidextractum	..	...	...	.....	freely	
	Mistura comp. brown mixture	..	...	...	fʒ1–4	4–15	
	Pulvis compositus	..	...	...	ʒ½–2	2–8	*Laxative:* Contains senna.
	Glycyrrhizinum ammoniatum	..	sol.	sol.	gr. 2–10	0.12–1.20	Same uses as licorice.
	Gold; *see* Aurum						
	Golden seal; *see* Hydrastis						
	Gossypium purificatum, cotton (g. herbaceum, hairs of seed)	..	...	...	.....	.....	To prepare surgical dressings; as absorbent.
	Oleum gossypii seminis (cotton-seed oil)	..	...	...	.....	.....	*Emollient:* substitute for olive oil; applied to burns, etc.
	Goulard's extract; *see* Plumbum						
	Gray powder; *see* Hydrargyrum						
	Green soap; *see* Sapo mollis						

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	Guaiacum (g. officinale or g. sanctum) guaiac (resin)	..	...	...	gr. 5–30	0.30–2	*Alterative:* In rheumatism, gout, tonsillitis, myalgia, sciatica and syphilis.
	Tinctura guaiaci	..	...	...	fʒ½–2	2–8	
	Tinctura guaiaci ammoniata	al.	...	...	fʒ¼–1	1–4	
	Guaiacol; *see* under Creosotum						
	Guarana (from Paullinia cupana, seeds)	..	...	...	ʒ¼–1	1–4	*Tonic; Stimulant:* Similar in action to coffee; used in migraine.
	Fluidextractum guaranæ	..	...	...	fʒ¼–1	1–4	
	Gum Arabic; *see* Acacia						
	Guncotton; *see* Pyroxylinum						
	*Gutta-percha (soluble in chloroform, oil of turpentine, carbon disulphide or benzin)	..	insol.	insol.	.....	.....	*Protective:* In making splints and surgical appliances; as temporary filling for teeth.
97	*Hamamelis, witch-hazel (h. virginiana leaves and bark)	..	...	...	ʒ½–2	2–8	Feeble *astringent:* In hemorrhages, hemorrhoids; locally to bruises and inflammations.
	Aqua hamamelidis						
	Fluidextractum	..	...	...	fʒ½–2	2–8	
	*Hedeoma, pennyroyal (leaves and fl. tops)	..	...	...	.....	.....	*Aromatic; Carminative:* In colic; used also externally.
	Oleum hedeomæ	..	...	...	♏1–5	0.06–0.30	
	*Heroin; *see* Diacetylmorphine						
158	Hexamethylenamina, urotropin	al.	1.5	12.5	gr. 5–15	0.30–1	*Antiseptic:* When given internally liberates formaldehyde during elimination by the kidneys.
	Hoffman's anodyne; *see* under Æther						
	*Holocaine hydrochloride	N.	40†	...	.....	extern.	*Local analgesic:* Same uses as cocaine, but probably more toxic.
	Homatropine; *see* under Atropine						
	Honey; *see* Mel.						
233	Hydrargyrum, mercury, a metal	..	insol.	insol.	.....	.....	Metallic mercury used in gray powder, blue pill, and ointment, in a very finely divided state; preparations of mercury are *alterative* and *purgative;* it is the chief remedy in secondary syphilis; blue pill is *cathartic,* but should be followed by a saline; ointment and oleate by inunction to obtain systemic effect.
	Hydrargyrum cum creta, gray powder, 38%	..	...	...	gr. 2–10	0.12–0.60	
	Massa hydrargyri, blue pill, 33%	..	...	...	gr. 2–10	0.12–0.60	
	Oleatum (25% yellow oxide)	..	...	...	.....		
	Unguentum, blue ointment, 50%	..	...	...	.....		
	Unguentum hyd. dilutum, 30%	..	...	...	.....		
	Hydrargyrum ammoniatum, white precipitate	..	alm. insol.	alm. insol.	.....	extern.	
	Unguentum hydrargyri ammoniati, 10%	..	...	...	.....		
150 233 293	Hydrargyri chloridum corrosivum, mercuric chloride, corrosive sublimate	ac.	13.5	3.8	gr. 1/60–1/10	0.001–0.006	The most poisonous salts are *corrosive chloride, cyanide* and *red iodide.* Corrosive sublimate is efficient for internal use; in secondary and tertiary syphilis, is frequently combined with iodides; it is a powerful *antiseptic* in 1:2000 or weaker solution as douche or irrigation.
233	Hydrargyri chloridum mite, mercurous chloride, calomel	..	insol.	insol.	gr. ½–10	0.03–0.60	
	*Hydrargyri cyanidum	N.	12.8	15	gr. 1/60–1/10	0.001–0.006	
	Hydrargyri iodidum flavum	..	alm. insol.	insol.	gr. ⅙–½	0.01–0.03	
	Hydrargyri iodidum rubrum	N.	alm. insol.	115	gr. 1/60–1/10	0.001–0.006	
232	Liquor arseni et hydrargyri iodidi, Donovan's solution	..	...	...	♏1–8	0.06–0.50	

† Soluble in boiling water, which upon cooling leaves a 2.5 per cent. solution.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	Unguentum hydrargyri nitratis, citrine ointment	..	...	...	.....		Calomel is a mild and certain cathartic as occasional purge in fevers and inflammatory diseases; an efficient *diuretic* in dropsies; in diarrheas in small doses; locally as a sedative, alterative application to ulcers.
	Hydrargyri oxidum flavum	..	alm. insol.	insol.	.....		
	Unguentum hydrargyri oxidi flavi 10%	..	...	...	.....	extern.	
	Hydrargyri oxidum rubrum, red precipitate	..	alm. insol.	insol.	.....		
	Hydrargyri salicylas	..	alm. insol.	alm. insol.	gr. 1/8–1	0.008–0.06	The salicylate may be used hypodermically.
	*Black wash (1 gm. calomel, 115.5 c.c. lime-water)	..	...	...	.....	extern.	*Black wash* and *yellow wash* are applied to syphilitic ulcers.
	*Yellow wash (1 gm. corrosive sublimate, 308 c.c. lime-water)	..	...	...	.....	extern.	
	Hydrastis, golden seal (h. canadensis, root)	..	...	...	gr. 5–60	0.30–4	*Bitter tonic:* in atonic indigestion; alterative to mucous membranes; in diseases of genito-urinary organs.
	Extractum hydrastis	..	...	...	gr. 2–15	0.12–1	
	Fluidextractum	..	...	...	♏5–60	0.30–4	
	Glyceritum, 100%	..	...	...	♏5–60	0.30–4	
	Tinctura	..	...	...	fʒ½–2	2–8	
	Hydrastina	al.	sl. sol.	170	gr. ¼–½	0.015–0.03	
	Hydrastininæ hydrochloridum	ac.	v. s.	v. s.	gr. ½–1	0.03–0.06	*Hemostatic:* In uterine hemorrhages, dysmenorrhea.
115 153	Hydrogen dioxide, official as liquor hydrogenii dioxidi (3%), peroxide of hydrogen, 10-volume solution, in water	sl. ac.	...	...	local use	.....	*Disinfectant:* To clean ulcers and wounds; to clean pulp chambers and canals.
80 161	Ethereal solution of hyd. dioxide, 25%	..	...	...	local use	.....	*Caustic:* to bleach teeth.
	Hydronaphtol; *see* Betanaphtol						
223 293	Hyoscinæ hydrobromidum; *see* Scopolamine						
293	Hyoscyamus, henbane (h. niger, lvs. and fl. tops)	..	...	...	gr. 2–10	0.12–0.60	In action it is similar to belladonna, but more *sedative* and *hypnotic;* in insomnia, mania, delirium tremens; it quiets peripheral irritation, nervous cough, irritability of bladder.
	Extractum hyoscyami	..	...	...	gr. ½–2	0.03–0.12	
	Fluidextractum	..	...	...	♏2–10	0.12–0.60	
	Tinctura	..	...	...	fʒ¼–1	1–4	
223	Hyoscyaminæ hydrobromidum	N.	v. s.	2.5	gr. 1/200	0.0003	Hyoscyamine is *anodyne* and *mydriatic.*
	Hypophosphites	..	...	...	.....	.....	*Tonic; Restorative:* In wasting diseases, tuberculosis, rachitis, nervous diseases.
231	Syrupus hypophosphitum	..	...	...	fʒ1–4	4–15	
	*Syrupus hypophos. compositus	..	...	...	fʒ1–2	4–8	
254	Hypophysis sicca, dried pituitary body	..	...	...	gr. ¼–1	0.015–0.06	*Oxytocic:* Causes stimulation of vascular system, with increased blood-pressure.
	Liquor hypophysis	..	...	...	♏15	1	
	*Pituitrin	..	...	...	♏8–30	0.5–2	
	*Ichthyol	sl. ac.	sol.	part.	.....	extern.	*Antiseptic; Alterative:* Applied to skin diseases, inflammations.
	*Lotion or ointment	..	...	...	.....	extern.	
	Indian hemp; *see* Cannabis indica						
	Iodine; *see* Iodum						
143	Iodoformum, iodoform. 96.7% iodine	N.	alm. insol.	60	gr. 1–5	0.06–0.30	Used externally; *alterative; antiseptic:* as powder to wounds and ulcers.
	Unguentum iodoformi, 10%	..	...	...	.....	extern.	
143	*Iodolum, iodol, 89% iodine	..	insol.	9	gr. ½–3	0.03–0.20	*Antiseptic:* Same uses as iodoform.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
63, 65, 143, 233, 293	Iodum, iodine	..	2950	12.5	.....	.....	*Alterative; Antiseptic:* In tertiary syphilis, scrofula, glandular enlargements; internally mostly in the form of iodides; the tincture is much used as a counter-irritant; to disinfect wounds, to prepare site of operation.
	Liquor iodi compositus, Lugol's solution, 5% iodine, 10% iodide of potassium	..	...	...	♏1–5	0.06–0.30	
	Tinctura iodi, 7%	..	...	...	♏1–3	0.06–0.20	
	Unguentum, 4%	..	...	...	.....	extern.	
91, 251, 252	Ipecacuanha, ipecac (cephaelis i. root)	..	...	...	gr. 1–30	0.06–2	
	Fluidextractum ipecacuanhæ	..	...	...	♏1–5 ♏15–30	0.06–0.30 1–2	*Expectorant.* *Emetic* in large doses; one of the safest emetics; in cough mixtures, and in treatment of pyorrhea; syrup to children in croup and bronchitis, to rid air passages of mucus; in diarrheas combined with other remedies; *diaphoretic* when combined with opium.
	Syrupus, 7%	..	...	...	♏5–fʒ2	0.30–8	
	Pulvis i. et opii; *see* under Opium						
	Tinctura i. et opii; *see* under Opium; *see* Emetine						
284	*Iris florentina, orris root	..	...	...	gr. 5–30	0.30–2	Used chiefly in tooth powders; tincture in perfumery and as flavoring.
	Iron; *see* Ferrum						
	Itrol; *see* Argenti citras						
	Jaborandi; *see* Pilocarpus						
Plate xviii	Jalapa (exogonium purga, root)	..	...	...	gr. 5–20	0.30–1.30	*Hydragogue cathartic:* In dropsies; as depleting agent in cerebral hyperemia or serous effusions.
	Pulvis comp.				ʒ½–2	2–8	
	Resina	sl. ac.	insol.	sol.	gr. 1–10	0.06–0.60	
	*Juniperus communis (ripe fruit)	..	...	...	ʒ¼–1	1–4	*Stimulant diuretic:* Usually combined with other diuretics; in dropsies, chronic catarrhs of urinary tract.
251	Oleum juniperi	..	insol.	4	♏2–10	0.12–0.60	
	Spiritus	..	...	...	fʒ¼–1	1–4	
	Spiritus comp.	..	...	...	fʒ1–4	4–15	
	*Infusion	..	...	...	f℥½–2	15–60	
97	Kino (pterocarpus marsupium, inspissated juice)	..	sl. sol.	sol.	gr. 5–15	0.30–1	*Astringent:* In diarrheas; as gargle.
	Tinctura kino	..	...	...	fʒ¼–2	1–8	
97	*Krameria, rhatany (k. triandra and k. ixina, root)	..	...	...	gr. 5–15	0.30–1	*Astringent:* In diarrheas, hemorrhages; locally to relaxed mucous membranes, spongy gums; as injection in fissure of anus or hemorrhoids.
	*Extractum kramerìæ	..	...	...	gr. 5–10	0.30–0.60	
	*Fluidextractum	..	...	...	♏5–30	0.30–2	
	*Tinctura	..	...	...	fʒ½–2	2–8	
	*Trochisci	..	...	...	1–5 troches		
	Labarraque's solution; *see* under Chlorine						
	Lactucarium, lettuce (lactuca virosa, concrete juice)	..	...	...	gr. 5–30	0.30–2	Mild *sedative* and *hypnotic*, somewhat like opium, but much feebler; used chiefly as vehicle.
	Syrupus lactucarii	..	...	...	fʒ1–4	4–15	
	Tinctura	..	...	...	fʒ¼–1	1–4	
	Lanolin; *see* Adeps lanæ hydrosus						
	Lard; *see* Adeps						
	Laudanum; *see* under Opium						
	Laughing gas; *see* Nitrogenii monoxidum						
	*Lavandula officinalis, lavender (flowers)						
	Oleum lavandulæ	..	...	...	♏1–5	0.06–0.30	*Flavoring agent:* As carminative.
	Spiritus	..	...	...	fʒ½–1	2–4	
	Tinctura comp.	..	...	...	fʒ½–1	2–4	
	Lead; *see* Plumbum						
	Lemon peel; *see* Limonis cortex						
	Licorice root; *see* Glycyrrhiza						
	Lily of the valley; *see* Convallaria						
	Lime; *see* Calx						

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	Limonis cortex, lemon peel	..	...	...	.....	.....	Preparations of lemon peel used chiefly as *flavoring agents;* the syrup of citric acid as *vehicle.*
	Oleum limonis	..	...	3	♏2–10	0.12–0.60	
	*Spiritus	..	...	...	freely	.....	
	*Limonis succus, lemon-juice	ac.	...	...	.....	freely	*Antiscorbutic:* In scurvy, acute rheumatism; refrigerant drink in fevers; to lessen acidity of urine; as vehicle.
	Syrupus acidi citrici	ac.	...	...	fʒ1–4	4–15	
	Linseed oil; *see* under Linum						
91	Linum (l. usitatissimum), flaxseed	..	.....	...	.....	.....	In poultices; infusion as *demulcent* drink; oil is *demulcent;* applied freely to burns.
90	Oleum lini, linseed oil	..	...	...	f℥½–2	15–60	
	*Infusion	..	...	...	.....	freely	
	*Lithium, a metal						
	Lithii bromidum	sl. al.	0.6	v. s.	gr. 5–20	0.30–1.30	*Antacid; Diuretic:* Salts used to produce alkalinity of urine in uric acid diathesis, gout.
	Lithii carbonas	al.	78	insol.	gr. 2–10	0.12–0.60	
	Lithii citras	N.	1.4	alm. insol.	gr. 2–10	0.12–0.60	
	*Litmus, lacmus	..	...	...	.....	.....	*Coloring agent:* To prepare test paper for acids and alkalies.
	*Tincture						
	Lobelia (l. inflata), Indian tobacco (leaves and tops)	..	...	...	gr. 1–5	0.06–0.30	*Emetic; Expectorant:* Too harsh as an emetic; used as antispasmodic in asthma; in bronchitis; has been used in poisoning by poison ivy.
	Fluidextractum lobeliæ	..	...	...	♏1–5	0.06–0.30	
	Tinctura	..	...	...	♏5–30	0.30–2	
143	*Losophane, cresol triiodide, 78% iodine	..	...	...	.....	.....	*Antiseptic:* Locally in solution or ointment in parasitic skin diseases, but not when acute inflammation is present.
	Lugol's solution; *see* under Iodum						
	Lunar caustic; *see* under Argentum						
	Lycopodium (l. clavatum and other species) (sporules)	..	...	...	.....	.....	Applied to excoriated surfaces as *protective* and *absorbent;* in preparing pills.
	*Lysol; *see* under Cresol						
	*Magnesium, a metal						
120 291	Magma magnesiæ, milk of magnesia	al.	misc.	...	fʒ1–4	4–15	*Antacid; Laxative;* also as *antidote.*
	Magnesii carbonas	al.	alm. insol.	insol.	ʒ¼–2	1–8	*Antacid; Laxative:* In acidity of stomach.
120	Magnesii oxidum	al.	spar.	insol.	gr. 5–60	0.30–4	To prepare antidote to arsenic; light and heavy oxides and carbonate are mild laxatives; the sulphate is active cathartic; as cathartic in fevers, inflammations, obstruction to portal circulation, dropsies.
	Magnesii oxidum ponderosum, heavy mag. oxide	al.	spar.	insol.	gr. 5–60	0.30–4	
Plate xviii	Magnesii sulphas, Epsom salt	N.	1	alm. insol.	℥¼–1	8–30	
	Male fern; *see* Aspidium						
	Maltum, barley malt	..	...	...	.....	.....	*Food tonic; Digestant:* In wasting diseases; to aid digestion of starch.
	Extractum malti	..	...	...	fʒ1–4	4–15	
	Mandrake; *see* Podophyllum						
	*Manganum, manganese						
	Mangani dioxidum præcipitatum	..	insol.	insol.	gr. 2–10	0.12–0.60	*Tonic* in small doses; *emmenagogue.*
146	Potassii permanganas	N.	13.5	†	gr. ½–2	0.03–0.12	*Antiseptic:* Used locally in diphtheria, scarlatina, etc.
	Manna (from fraxinus ornus)	..	...	...	℥¼–1	8–30	*Demulcent; Laxative,*
	*Mastiche, a resin from pistacia lentiscus	..	insol.	part.	.....	.....	In dentistry to fill cavities of carious teeth temporarily.
	May apple; *see* Podophyllum						

† Decomposition occurs.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
223 228 Plate xi 294	Nux vomica (strychnos n. v., seeds)	..	...	...	gr. ½–2	0.03–0.12	*Bitter tonic; Stimulant* to nervous system; in atonic indigestion, gastric catarrh; in paralysis, incontinence of urine, neuralgia and respiratory and cardiac weakness.
	Extractum nucis vomicæ	..	...	...	gr. ⅛–½	0.0075–0.03	
	Fluidextractum	..	...	...	♏½–2	0.03–0.12	
	Tinctura	..	...	...	♏5–20	0.30–1.30	
	See Strychnina						
	*Oleum betulæ, oil of sweet birch	N.	insol.	sol.	♏1–5	0.06–0.30	Same uses as oleum gaultheriæ.
	Oleum cadinum (from juniperus oxycedrus) oil of cade	ac.	alm. insol.	part.	.....	.....	*Externally:* In scabies, psoriasis.
137 140	Oleum cajuputi, oil of cajuput	N.	insol.	1	♏1–10	0.06–0.60	*Stimulant; Antiseptic:* As carminative.
231	Oleum morrhuæ, cod-liver oil	sl. ac.	insol.	sl. sol.	fʒ1–4	4–15	*Tonic; Alterative:* As a fatty food in wasting diseases.
	Emulsum olei morrhuæ	..	...	...	fʒ2–8	8–30	
	Oleum olivæ, olive oil	..	insol.	sl. sol.	.....	freely	*Laxative; Emollient*
Plate xviii	Oleum ricini, castor oil	..	insol.	1	f℥¼–2	8–60	*Cathartic.*
	Oleum santali, oil of sandal-wood	sl. ac.	insol.	sol.	♏2–10	0.12–0.60	*Alterative:* Gonorrhea, chronic bronchitis.
Plate xviii 66	Oleum tiglii, croton oil	ac.	insol.	sl. sol.	♏¼–2	0.015–0.12	*Drastic cathartic:* Used as *revulsive;* externally it is *vesicant.*
246 Plate xvii 114 294	Opium; concrete juice of unripe capsules of opium poppy (papaver somniferum), containing not less than 9.5% morphine	..	...	...	gr. ¼–2	0.015–0.12	*Anodyne* and *narcotic:* danger of poisoning and habitual use must be guarded against; it lessens secretions except perspiration; moderate doses, according to some, stimulate the heart; after-effects of a full dose are headache, nausea and constipation.
	Opium deodoratum Opium granulatum Opii pulvis, each contains 10–10.5% morphine	..	...	...	gr. ¼–1½	0.015–0.10	
	Extractum opii	..	...	...	gr. ⅛–1	0.0075–0.06	Used to relieve pain and spasm; in diarrhea and dysentery to lessen peristalsis; in pneumonia, bronchitis, and pleuritis to allay pain and cough. In peritonitis typhoid fever, typhlitis, etc., to lessen pain and peristalsis; in heart diseases with angina pectoris or cerebral anemia; Dover's powder is *diaphoretic*, very useful in pulmonary diseases, myalgia, lumbago, etc.; for hypodermic use morphine is preferred.
	*Pilulæ opii	..	...	...	gr. 1 in each		
	The following contain each 10% opium: *Acetum opii, black drop Tinctura opii, laudanum Tinctura opii deodorati *Tinctura ipecacuanhæ et opii *Vinum opii	..	...	...	♏3–15	0.20–1	
262	Pulvis ipecacuanhæ et opii, Dover's powder, 10% opium	..	...	...	gr. 3–15	0.20–1	
247 294	Tinctura opii camphorata, paregoric, 0.4% opium	..	...	...	♏3–20 child fʒ1–4 adult	0.20–1.20 4–15	
	See Codeina and Morphinæ						
	Orange peel; *see* Aurantii cortex						
	Orris root; *see* Iris florentina						
	*Orthoform	N.	sl. sol.	sol.	gr. 1–15	0.06–1	*Analgesic:* Applied locally to painful ulcers or wounds.
	Otto of rose; *see* under Rosa						
	Oxygenium, oxygen	..	...	...	.....	inhaled	*Restorative:* In pulmonary diseases, apnea, croup, diphtheria; also used with anesthetics.
255	Pancreatinum, pancreatin	..	sol.	insol.	gr. 5–15	0.30–1	*Digestant:* Aids digestion of starches, fats and proteids; also used to peptonize milk and other foods before feeding.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	Paraffinum (from petroleum)	..	insol.	insol.	extern.	.....	*Protective:* To protect surfaces from moisture or air.
	Paraform; *see* under Formaldehyde						
	Paraldehydum	N. or sl. ac.	8	misc.	fʒ¼–1	1–4	*Hypnotic:* Less certain than chloral, but safer.
	Paregoric; *see* under Opium						
	Pearson's solution; *see* under Arseni trioxid						
	Pennyroyal; *see* Hedeoma						
	Pepo, pumpkin seed	..	...	...	℥1–3	30–90	*Anthelmintic:* Given in emulsion to remove tapeworm.
	Pepper, Cayenne; *see* Capsicum						
	Peppermint; *see* Mentha piperita						
255	Pepsinum, pepsin	sl. ac.	50	alm. insol.	gr. 1–15	0.06–1	*Digestant:* In indigestion due to lack of gastric juice.
	Peroxide of hydrogen; *see* hydrogen dioxide						
28	Petrolatum, vaseline						
	Petrolatum album, albolene	..	...	...	.....	.....	Basis for ointments.
90	Petrolatum liquidum	..	...	...	f℥¼–1	8–30	*Laxative* internally; *demulcent* locally; as vehicle.
	*Petroleum, coal oil	..	...	...	.....	.....	Source of rhigolene benzin, petrolatum, paraffin, etc.
	Phenacetin; *see* Acetphenetidinum						
75 127 291	Phenol, carbolic acid	sl. ac.	15	v. s.	gr. ½–2	0.03–0.12	*Corrosive; Antiseptic; Local sedative* in dilute solution; as mouth-wash, gargle or internal antiseptic; in vomiting, diarrhea, and indigestion due to fermentation.
	Phenol liquefactum, 87%						
	Glyceritum phenolis, 20%						
	Unguentum						
128	*Liquor sodii carbolatis, phenol sodique	..	...	...	local use		
Plate xviii	Phenolphthaleinum, phenolphthalein	..	alm. insol.	13	gr. 1–5	0.06–0.30	*Cathartic:* Safe and efficient; *reagent.*
135	Phenylis salicylas, salol	N.	6670	6	gr. 1–5	0.06–0.30	Intestinal *antiseptic;* in diarrhea, fermentative indigestion, rheumatism.
230	Phosphorus	..	insol.	400†	gr. 1/120	0.0005	*Restorative tonic:* In depressed condition of nervous system, neuralgia; largely employed in form of phosphoric acid, phosphates, and hypophosphites as general restorative in wasting diseases.
295	Pilulæ phosphori	..	...	...	gr. 1/100 in each		
	See Acidum phosphoricum						
	See Hypophosphites						
	Physostigma (p. venenosum), calabar bean	..	...	...	gr. ½-2	0.03–0.12	*Sedative; Myotic:* To depress excitability of spinal cord; in tetanus, strychnine poisoning, progressive paralysis of the insane; to contract pupil.
	Extractum physostigmatis	..	...	...	gr. 1/10–½	0.006–0.03	
	Tinctura	..	...	...	♏10–30	0.60–2	
	*Eserine (same as physostigmine)						
	Physostigminæ salicylas	N. or sl. ac.	75	16	gr. 1/100–1/20	0.0006–.002	To contract pupil.
	Pilocarpus (p. jaborandi, leaflets)	..	...	...	gr. 5–60	0.30–4	Powerful *diaphoretic; sialagogue;* in acute catarrh, acute inflammations of serous membranes; in acute sthenic fevers and dropsies when heart is not weak; pilocarpine may be used hypodermically.
	Fluidextractum pilocarpi	..	...	...	♏5–60	0.30–4	
251	Pilocarpinæ hydrochloridum	N. or sl. ac.	0.3	3	gr. 1/12–⅓	0.005–0.02	
	Pilocarpinæ nitras	ac.	4	75	gr. 1/12–⅓	0.005–0.02	
	Pilulæ catharticæ comp; *see* under Colocynthis						

† Absolute alcohol.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	*Pilulæ catharticæ veg.; *see* under Colocynthis						
	Piperina (from pepper, piper nigrum)	N.	insol.	15	gr. 1–5	0.06–0.30	*Antiperiodic; Antipyretic.*
	*Piperazine, piperazidine	..	sol.	...	gr. 8–15	0.50–1	As solvent for uric acid; in gout and allied conditions.
	Pituitrin; *see* under Hypophysis						
	Pix liquida, wood tar (from pine)	ac.	sl. sol.	sol.	gr. 5–15	0.30–1	Used externally in chronic eczema, psoriasis; with atomizer or in the form of syrup in laryngitis, bronchitis, catarrhs, phthisis.
	Oleum picis liquidæ	..	...	...	.....	extern.	
	Syrupus	..	...	...	fʒ 1–4	4–15	
	Unguentum, 50%	..	...	...	.....	extern.	
	Plaster of Paris; *see* Calcii sulphas						
	*Platinum, a metal						
	*Platinic chloride	..	v. s.	v. s.	gr. ½–2	0.03–0.12	*Alterative.*
	*Plumbum, lead						
104 293	Plumbi acetas, sugar of lead	sl. al.	1.4	38	gr. ½–2	0.03–0.12	*Sedative astringent:* Acetate used as sedative application to irritable ulcers; in skin diseases; astringent in inflammations and catarrhal discharges; internally in hemorrhages, diarrheas, gastric ulcer; nitrate as *deodorant* to foul ulcers; with glycerin as astringent to fissured nipples; oxide used to prepare lead plaster, which forms the basis of many other plasters.
	Liquor plumbi subacetatis, Goulard's extract	al.	...	...	.....	extern.	
105	Liquor plumbi subacetatis dilutus, lead-water	al.	...	...	.....	extern.	
	*Plumbi nitras	ac.	1.85	spar.	.....	extern.	
	Plumbi oxidum, litharge	al.	alm. insol.	insol.	.....	extern.	
	Emplastrum plumbi, lead plaster; diachylon plaster	..	...	...	.....	extern.	
	Unguentum diachylon	..	...	...	.....	extern.	
Plate xviii	Podophyllum, mandrake (p. peltatum, root)	..	...	...	.....	.....	*Cathartic:* Efficient in torpor of the liver; in chronic constipation; the resin used in laxative pills.
	*Extractum podophylli	..	...	...	gr. 2–10	0.12–0.60	
	Fluidextractum	..	...	...	♏5–15	0.30–1	
	Resina, "podophyllin"	..	insol.	sol.	gr. ⅛–½	0.0075–0.03	
	*Potassium, a metal	..	...	...	.....	.....	*Alkali:* Potass. hydroxide is caustic; liq. pot. hydrox. diluted and the carbonates are used as alkalies.
250	Potassii acetas	al.	0.5	2.9	gr. 5–30	0.30–2	
	Liquor potassii arsenitis; *see* under Arseni trioxid						
	Potassii bicarbonas	al.	2.8	alm. insol.	gr. 5–30	0.30–2	
250 295	Potassii bitartras, cream of tartar	ac.	155	alm. insol.	ʒ½–4	2–15	
239	Potassii bromidum	N.	1.5	250	gr. 5–60	0.30–4	The salts with vegetable acids also act as alkalies, being converted into carbonates in the system, and in elimination they are *diuretic;* in fevers, rheumatism; to produce alkalinity of the urine; bitartrate and Rochelle salt are *cathartics;* chlorate is *detergent* when applied to mucous membranes — poisonous in large doses; best used alone as may form explosive mixtures. Bromide is a *nerve sedative* with same action as sodium bromide, but slightly less efficient and more irritating.
	Potassii carbonas	al.	0.9	insol.	gr. 5–30	0.30–2	
145	Potassii chloras	N.	11.5	sl. sol.	gr. 2–10	0.12–0.60	
295	Trochisci potassii chloratis	..	...	...	gr. 2½ in each		
250	Potassii citras	al.	0.6	sl. sol.	gr. 5–30	0.30–2	
	Liquor potassii citratis	sl. ac.	...	...	fʒ 1–8	4–30	
293	*Potassii cyanidum	al.	2	sl. sol.	gr. 1/20–1/10	0.003–0.006	
74 295	Potassii hydroxidum, caustic potash	al.	0.9	3	.....	.....	
	Liquor potassii hydroxidi, 4.5%	al.	...	...	♏5–15 well diluted	0.30–1	
	*Potassa cum calce, Vienna paste, 50% each potash and lime	al.	...	...	.....	extern.	
Plate xviii	Potassi et sodii tartras, Rochelle salt	al.	0.9	alm. insol.	ʒ¼–1	8–30	
	Pulvis effervescens compositus, Seidlitz powder	..	...	...	set of two powders		
	Potassii hypophosphis	N.	0.6	9	gr. 5–20	0.30–1.30	
234	Potassii iodidum	N.	0.7	22	gr. 5–30	0.30–2	Iodide is *alterative* and *sialagogue;* in

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
250 295	Potassii nitras, nitre, saltpetre	N.	2.8	alm. insol.	gr. 5–15	0.30–1	tertiary syphilis, asthma, chronic bronchitis, chronic rheumatism; in lead poisoning to promote elimination.
146 162	Potassii permanganas	N.	13.5	decomp	gr. ½–2	0.03–0.12	
	*Potassii sulphas	N.	9	insol.	ʒ½–4	2–15	Permanganate as *antiseptic;* nitrate is *diuretic;* nitre paper as a fumigation in asthma; sulphate is a mild *cathartic,* but seldom used; useful to hasten hardening of plaster of Paris.
	Prepared chalk; *see* under Calcium						Cyanide is in action similar to *hydrocyanic acid;* poisonous.
149	*Protargol, a proteid compound of silver	..	sol.	...	.....	.....	*Antiseptic:* Applied in 1 to 5% solutions.
228	Prunus virginiana (p. serotina), wild cherry bark	..	...	...	ʒ½–1	2–4	*Bitter tonic: Sedative,* by virtue of hydrocyanic acid, which is developed in the cold infusion; in pulmonary diseases, coughs, dyspepsia.
	*Fluidextractum pruni virginianæ	..	...	...	fʒ½–1	2–4	
	*Infusion	..	...	...	f℥1–2	30–60	
	Syrupus	..	...	...	fʒ1–4	4–15	
	Prussic acid; *see* Acidum hydrocyanicum dil.						
	Pumpkin seed; *see* Pepo						
	Pyrethrum (anacyclus p., root)	..	...	...	ʒ¼–1	1–4	*Sialagogue; Irritant:* As gargle; as snuff in chronic catarrh.
	Tinctura pyrethri	..	...	...	.....	extern.	
	Pyrogallol, pyrogallic acid	N. or ac.	1.7	1.3	.....	.....	*Caustic:* Poisonous.
	*Ointment, 2–3%	..	...	...	.....	.....	Externally in skin diseases.
114	Pyroxylinum, soluble guncotton	..	insol.	†	.....	.....	To prepare collodion and celluloid.
227	Quassia (picrasma excelsa, wood)	..	...	...	.....	.....	*Bitter tonic; Anthelmintic:* In atonic indigestion; infusion as enema to remove thread-worms; *contains no tannin.*
	Tinctura	..	...	...	fʒ¼–1	1–4	
	*Infusion	..	...	...	f℥1–2	30–60	
	*Quercus, white oak (bark)	..	...	...	.....	.....	*Astringent:* Same uses as tannic acid.
	*Fluidextractum	..	...	...	fʒ¼–1	1–4	
227	Quinina	al.	1560	0.8			Quinine is the chief remedy used in malarial fevers; the sulphate is used mostly, but the bisulphate is more soluble; the hydrobromide, hydrochloride and dihydrochloride are recommended for hypodermic use.
	Quininæ bisulphas	ac.	9	23			
	Quininæ dihydrochloridum	ac.	0.6	12			
	Quininæ hydrobromidum	N.	40	0.9	gr. 1–20	0.06–1.30	
	Quininæ hydrochloridum	N.	18	0.8			
	Quininæ salicylas	al.	sl. sol.	14			
	Quininæ sulphas	N.	725	107			
	*Compound tincture (Warburg's)	..	...	...	fʒ2–6	8–25	
181	Quininæ et ureæ hydrochloridum	ac.	0.9	2.4	gr. 1–15	0.06–1	*Local analgesic:* Has prolonged action.
	Quininæ tannas	..	sl. sol.	sl. sol.	gr. 2–10	0.12–0.60	The tannate is less active, but is nearly tasteless.
	Red precipitate; *see* Hydrargyri oxidum rubrum						
	Resina (from turpentine), rosin	..	insol.	sol.	.....	.....	In plasters and ointments.
	Ceratum resinæ, basilicon ointment	..	...	...	.....	extern.	Resin cerate is applied to bruises, ulcers, etc.
145	Resorcinol, resorcin	N.	0.9	0.9	gr. 2–5	0.12–0.30	*Antiseptic:* May use internally; in pertussis, 2% solution used as a spray to the upper air tract.
	Rhamnus frangula, buckthorn; *see* Frangula						
	Rhatany; *see* Krameria						

† Soluble in 25 parts of a mixture of 3 vols. ether with 1 vol. alcohol.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
Plate xviii	Rheum, rhubarb (r. officinale, root)	..	...	...	gr. 3–30	0.20–2	*Astringent; Cathartic.* Small doses tonic to intestinal tract; larger doses safe, efficient *laxative;* cathartic effect apt to be followed by constipation unless combined with more powerful agents, as in compound pill; its astringency makes it a valuable laxative in diarrheas.
	Extractum rhei	..	...	...	gr. 3–15	0.20–1	
	Fluidextractum	..	...	...	♏3–30	0.20–2	
	Pilulæ compositæ	..	...	...	1–3 pills		
	Pulvis compositus	..	...	...	ʒ¼–1	1–4	
	Syrupus Syrupus aromaticus	.. ..	... ...	... ...	child ʒ1	child 4	
	Tinctura	..	...	...	fʒ½–2	2–8	
	Tinctura aromatica	..	...	...	fʒ¼–1	1–4	
165	*Rhigolene (from petroleum)	..	...	...	.....	.....	Used as local analgesic.
	Rochelle salt; *see* Potassii et sodii tartras						
	*Rhus glabra, sumach (fruit)	..	...	...	ʒ¼–1	1–4	*Astringent:* As mild astringent, gargle, or lotion.
	*Fluidextractum rhois glabræ	..	...	...	fʒ¼–1	1–4	
	*Rosa damascena, damask rose						
285	Oleum rosæ, otto of rose	N.	insol.	sl. sol.	.....	.....	*Flavoring agent:* Perfume.
	Rosa centifolia						
	Aqua rosæ	..	...	...	.....	.....	Rose water as vehicle or flavor.
	Aqua rosæ fortior						
	Unguentum aquæ rosæ, cold cream	..	...	...	.....	.....	Cold cream to soften the skin; applied to chapped hands.
	Rosa gallica, red rose (dried petals)	..	...	...	.....	.....	*Flavoring agent.*
	Fluidextractum	..	...	...	fʒ¼–1	1–4	Fluid extract as vehicle; the honey locally as mouth-wash.
	Mel., honey of rose	..	...	...	.....	freely	
	*Rubus, blackberry (bark of root)	..	...	...	.....	.....	*Astringent:* In diarrheas.
	*Fluidextractum rubi	..	...	...	fʒ½–2	2–8	
	*Syrupus	..	...	...	fʒ1–2	4–8	
	Saccharine; *see* Benzosulphinidum						
30 264	Saccharum, cane-sugar	N.	0.5	170	.....	.....	*Sweetening agent; Preservative.*
	Syrupus	..	...	...	.....	.....	Syrup as vehicle.
30	Saccharum lactis, sugar of milk	N.	5	alm. insol.	.....	.....	The hardness of its particles make it useful in preparing triturations.
	Sage; *see* Salvia						
	Salicinum, salicin (from several species of salix and populus)	N.	23.5	88.5	gr. 5–30	0.30–2	*Tonic; Antiperiodic:* In rheumatism, malarial fevers.
	Salol; *see* phenylis salicylas						
	Saltpetre; *see* Potassii nitras						
	*Salvia (s. officinalis) sage leaves	..	...	...	ʒ¼–1	1–4	*Astringent:* Infusion as gargle, often with alum.
35	Santoninum (from santonica), santonin	N.	insol.	43	gr. ¼–1 child	0.015–0.06	*Anthelmintic:* To destroy round worms, used cautiously.
29 117	Sapo, white Castile soap	al.	v. s.	v. s.	gr. 5–15	0.30–1	Seldom internally except in suppository or pill; powdered, used as an *alkali* and *detergent* in dentifrices; soft soap as *antiseptic;* in diseases of the skin.
	Linimentum	..	...	...	.....	extern.	
117	Sapo mollis, soft soap, green soap	al.	v. s.	v. s.	.....	extern.	
	Linimentum saponis mollis	al.	...	...	.....	extern.	
237	Sarsaparilla (root)	..	...	...	.....	.....	*Tonic; Alterative:* Has very feeble medicinal powers; used chiefly as vehicle for stronger alteratives.
	Fluidextractum	..	...	...	fʒ½–1	2–4	
	Fluidextractum comp.	..	...	...	fʒ½–1	2–4	
	Syrupus comp.	..	...	...	fʒ¼–1	8–30	

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	Sassafras (s. variifolium, bark of root)	..	...	...	ʒ¼–1	1–4	The warm infusion is *diaphoretic;* regarded as alterative, but has feeble power.
	Oleum sassafras	..	...	...	♏1–5	0.06–0.30	
250 252	Scilla, squill (urginea maritima, bulb)	..	...	...	.....	.....	*Diuretic; Expectorant:* In large doses *emetic;* like digitalis, it strengthens pulse and increases excretion of urine; in bronchitis, croup; the compound syrup cautiously with children.
	Acetum scillæ	ac.	...	...	♏10–30	0.60–2	
	Fluidextractum	..	...	...	♏1–5	0.06–0.30	
	Syrupus	ac.	...	...	fʒ¼–1	1–4	
	Syrupus comp., hive syrup (0.2% tartar emetic)	..	...	...	♏5–30	0.30–2	
	Tinctura	..	...	...	♏5–30	0.30–2	
223 293	Scopolaminæ hydrobromidum, hyoscine hydrobromide (from various plants of the Solanaceæ, but chiefly from the seed of hyoscyamus and stramonium)	N.	1.5	20	gr. 1/200	0.0003	*Mydriatic:* Resembles atropine and hyoscyamine in action and uses; with morphine to induce "twilight sleep."
	Senega (polygala s., root)	..	...	...	gr. 10–20	0.60–1.30	*Stimulant expectorant: Diuretic:* In chronic bronchitis, asthma, croup; often combined with squill.
	Fluidextractum senegæ	..	...	...	♏10–20	0.60–1.20	
	Syrupus	..	...	...	fʒ½–2	2–8	
Plate xviii	Senna (cassia acutifolia and c. angustifolia, leaves)	..	...	...	ʒ1–2	4–8	*Cathartic:* Efficient and safe in any condition, except intestinal inflammation; the confection and compound licorice powder are mild, useful for children and in pregnancy.
	Fluidextractum	..	...	...	fʒ½–2	2–8	
	Infusum comp.	..	...	...	f℥1–4	30–120	
	Pulvis glycyrrhizæ compositus	..	...	...	ʒ½–2	2–8	
	Syrupus	..	...	...	f℥¼–1	8–30	
254	Serum antidiphthericum, diphtheria antitoxin	..	...	...	.....	.....	In diphtheria, hypodermically, to antagonize poison of the disease.
255	Serum antitetanicum, tetanus antitoxin	..	...	...	.....	.....	In tetanus (lockjaw) hypodermically to antagonize poison of the disease; it is most successfully used as a prophylactic to prevent development of tetanus.
61	Sinapis alba, white mustard seed	..	...	...	ʒ1–4	4–15	*Rubefacient; Irritant emetic:* Mustard owes its irritant property to the volatile oil, which is developed in the presence of cold water.
61 251	Sinapis nigra (brassica nigra), black mustard seed	..	...	...			
	Emplastrum sinapis, mustard paper	..	...	...	.....	extern.	
61	Oleum sinapis volatile	N.	insol.	sol.	♏⅛–¼	0.0075–.015	The volatile oil is *antiseptic,* but very irritating.
	*Flour of mustard is a mixture of white and black						
	Slippery elm; *see* Ulmus						
	Soap; *see* Sapo						
	*Sodium, a metal	al. or N.	...	...	.....	.....	The general action and uses of sodium salts are similar to those of potassium; as *alkalies* they are less disturbing; being better tolerated by the system they are more slowly eliminated, therefore less diuretic. Liq. sod. hydrox., the acetate and carbonates as alkalies, the bicarbonate more than all others for internal use.
	Sodii acetas	al.	0.8	19	gr. 10–30	0.60–2	
	Sodii arsenas; *see* under Arseni						
	Sodii benzoas	N. or al.	1.8	61	gr. 5–30	0.30–2	
118	Sodii bicarbonas	al.	10	insol.			
	Trochisci sodii bicarbonatis	..	...	...	gr. 3 in each	0.20 in each	
	Sodii bisulphis; *see* under Acid, sulphurosum						
118	Sodii boras, borax	al.	15	insol.	gr. 5–30	0.30–2	
127	*Liquor sodii boratis compositus, Dobell's solution	al.	...	...	.....	extern.	

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
239	Sodii bromidum	N.	1.1	16	gr. 5–60	0.30–4	Benzoate and borate are *antiseptic;* the former in cystitis, to prevent decomposition of urine; borax as mouth-wash in thrush.
	Sodii cacodylas; *see* under Arseni trioxidum						
	Sodii carbonas monohydratus	al.	3	insol.	gr. 5–10	0.30–0.60	
48 221	Sodii chloridum, common salt	N.	2.8	alm. insol.	ʒ½–4	2–15	Bromide is *sedative;* large doses by enema to control obstinate vomiting due to reflex causes; most efficient remedy in epilepsy; in infantile convulsions, headaches, fevers, insomnia, nervousness, hysteria; sedative to sexual organs.
221	Liquor sodii chloridi physiologicus, normal salt solution	N.	...	...	1–2 pints	500–1000	
	Sodii citras	al.	1.3	insol.	gr. 5–30	0.30–2	
161	*Sodium dioxide	al.	sol.	...	.....	extern.	
74 295	Sodii hydroxidum, caustic soda	al.	0.9	v. s.			
	Liquor sod. hydroxidi, 4.5%	al.	...	...	♏5–15 diluted	0.30–1	
	Sodii hypophosphis	N.	1	25	gr. 5–20	0.30–1.30	Chloride in normal (0.85%) solution as cleansing lotion in diphtheria, nasal catarrh, pharyngitis, and hypodermically or intravenously as *restorative.*
234	Sodii iodidum	al.	0.5	2	gr. 5–30	0.30–2	
Plate xiii	Sodii nitris	al.	1.5	sl. sol.	gr. 1–3	0.06–0.20	
	Sodii perboras	al.	sol.	...			
	Sodii phenolsulphonas	N.	4.2	140	gr. 1–10	0.06–0.60	
Plate xviii	Sodii phosphas	al.	2.7	insol.	gr. 5–℥1	0.30–30	Dioxide is a *caustic* and *bleaching agent;* in saturated solution to bleach teeth; perborate also as bleaching agent.
135	Sodii salicylas	ac.	0.9	9.2	gr. 5–30	0.30–2	Hypophosphite is *tonic.*
Plate xviii	Sodii sulphas, Glauber's salt	N.	2	insol.	ʒ1–8	4–30	Phosphate and sulphate are *laxative.* Nitrite has same uses as nitroglycerin. Salicylate has same uses as salicylic acid. Phenolsulphonate is used internally for same purposes as carbolic acid.
	Sodii sulphis; *see* under Acidum sulphurosum						
	Sodii et potassii tartras; *see* Potassii et sodii tartras						
	Sodii thiosulphas (hyposulphite) *See* under Acid sulphurosum						
	Soda powders, effervescing powders, consist of one powder of bicarbonate of sodium and one of tartaric acid, taken together						
143	*Sozoiodol, sozoiodolic acid, 53% iodine	ac.	sl. sol.	...	.....	extern.	*Antiseptic:* In solution or as dusting powder.
	Spanish flies; *see* Cantharis						
	Sparteinæ sulphas (from scoparius)	N.	1.1	3	gr. 1/10–1	0.006–0.06	*Heart stimulant; Diuretic:* Acts more promptly than digitalis.
	Spearmint; *see* Mentha viridis						
	Spermaceti; *see* Cetaceum						
	Spiritus ætheris nitrosi; *see* under Æther, nitrous						
	Squill; *see* Scilla						
	Starch; *see* Amylum						
	Storax; *see* Styrax						
296	Stramonii folia (datura s., leaves)	..	...	...	gr. 1–3	0.06–0.20	*Narcotic; Anodyne:* Leaves as fumigation in asthma; similar to belladonna; as *antispasmodic* and *anodyne* in asthma, chorea, neuralgia, dysmenorrhea; ointment to painful ulcers.
	Extractum stramonii	..	...	...	gr. ⅛–¼	0.008–0.015	
	Tinctura	..	...	...	♏5–30	0.30–2	
	Unguentum	..	...	...	.....	extern.	

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	*Strontium, a metal						Salts of strontium act as do those of other earth metals; they are not poisonous, but are believed to aid nutrition.
	Strontii bromidum	N.	0.35	sol.	gr. 1–60	0.06–4	
	Strontii iodidum	..	0.2	sol.	gr. 5–30	0.30–2	
	Strontii salicylas	..	19	61	gr. 5–30	0.30–2	
	Strophanthus (s. Kombé, seeds)	..	...	...	.....	.....	*Heart stimulant; Diuretic:* Effect upon heart similar to that of digitalis.
	Tinctura strophanthi	..	...	...	♏2–15	0.12–1	
177 216 223 Plates iv, xi 294	Strychnina (from nux vomica)	al.	6240	136	gr. $^{1}/_{60}$–$^{1}/_{10}$	0.001–.006	*Bitter tonic; Nerve stimulant:* Action and uses same as those of nux vomica, which drug it represents fully.
	Strychninæ nitras	N.	42	150			
	Strychninæ sulphas	N.	32	81			
	Styrax, storax	..	insol.	1 warm	gr. 5–20	0.30–1.30	*Expectorant; Antiseptic:* In catarrhs, purulent mucous discharges; to preserve fats.
133	Tinctura benzoini composita, 8% of storax	..	...	...	♏5–60	0.30–1	
	Sugar; *see* Saccharum						
	Sugar of lead; *see* Plumbi acetas						
	Sugar of milk; *see* Saccharum lactis						
246	Sulphonethylmethanum, trional	N.	200	sol.	gr. 5–30	0.30–2	*Hypnotic:* Both are less depressing and safer than chloral.
246	Sulphonmethanum, sulphonal	N.	365	60	gr. 5–30	0.30–2	
Plate xviii	Sulphur lotum washed sulphur	N.	insol.	sl. sol. in absolute alcohol	ʒ¼–2	1–8	*Laxative; Alterative:* In chronic eczema, psoriasis, and other skin diseases, internally and externally; very effectual externally for scabies; washed s. most suitable for internal use.
	S. præcipitatum	N.					
	S. sublimatum, flowers of sulphur	ac.					
	Unguentum sulphuris, 15%	..	...	...	.....	extern.	
	Sulphuric ether; *see* Æther, ethylic						
	Sumach; *see* Rhus glabra						
253	Suprarenalum siccum, dried suprarenal glands; *see* under Adrenalin	..	...	...	gr. 1–10	0.06–0.60	
	Sweet almond; *see* Amygdala dulcis						
	Sweet birch oil; *see* Oleum betulæ						
	Sweet spirit of nitre; *see* under Æther, nitrous						
	*Tanacetum, tansy (t. vulgare, leaves and tops)	..	...	...	ʒ¼–1	1–4	*Emmenagogue; Anthelmintic:* Dangerous in large doses.
	*Volatile oil	..	...	...	♏1–3	0.06–0.20	
	Tartar emetic; *see* Antimonii et potassii tartras						
	Terebenum (from turpentine)	N.	sl. sol.	3	♏5–15	0.30–1	*Stimulant expectorant:* In cough, chronic bronchitis, hay asthma.
	*Terebinthina, turpentine, an oleoresin from pine	ac.	insol.	sol.			
62 296	Oleum terebinthinæ	N. or sl ac.	insol.	5	fʒ½–4 ♏5–15	2–15 0.30–1	*Anthelmintic.* *Stimulant; Diuretic:* Externally *vesicant;* internally in typhoid conditions, intestinal ulceration and hemorrhages; the crude French oil in phosphorus poisoning.
141	Oleum t. rectificatum	N.	insol.	5			
	Emulsum olei terebinthinæ, 15%	..	...	...	fʒ½–2	2–8	
63	Linimentum, 35%	..	...	...	.....	extern.	
	Terpini hydras, terpin hydrate	N.	200	13	gr. 2–10	0.12–0.60	*Antiseptic; Expectorant;* in bronchitis.
	*Tetronal	..	450	sol.	gr. 15–30	1–2	*Hypnotic.*
	*Theobroma cacao (seeds)	..	...	...	.....	.....	To prepare chocolate.
29	Oleum theobromatis, cacao butter	N.	insol.	100	.....	.....	In preparing suppositories.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Date.	Gm. or mil.	Uses.
223	*Theobromine	..	sl. sol.	sol.	gr. 2–10	0.12–0.60	*Diuretic:* Similar to caffeine, but less stimulating to cerebrum; very efficient as *diuretic.*
251	Theobromine and sodium salicylate, diuretin	al.	1	sl. sol.	gr. 5–15	0.30–1	
	*Thiosinamine (from vol. oil of mustard)	..	sl. sol.	sol.	gr. ½–2	0.03–0.12	*Resolvent; Antiseptic;* To soften scar tissue.
	*Thymus vulgaris, thyme (leaves)	..	...	...	ʒ¼–1	1–4	*Aromatic stimulant:* Mostly as infusion;
140	Oleum thymi	N.	insol.	2	♏1–5	0.06–0.30	oil as *carminative.*
140	Thymol	N.	1010	1	gr. 1–30	0.06–2	*Antiseptic:* Internally in hookworm disease.
141	Thymolis iodidum, aristol, 43% iodine	..	insol.	675	.....	extern.	*Antiseptic:* Substitute for iodoform.
253	Thyroideum siccum, dried thyroid gland	..	...	...	gr. 1–5	0.06–0.30	To supply the thyroid substance, as in myxedema, cretinism and obesity; in some cases of goitre.
	Tragacantha, gum tragacanth	..	part.	insol.	.....	.....	*Excipient* in making pills and troches;
	Mucilago tragacanthæ	..	...	...	.....	freely	mucilage as vehicle.
	Tricresol, *see* Cresol						
	Trinitrophenol, picric acid	ac.	78	12	gr. ½–2	0.03–0.12	Mostly externally; as application, in weak solution, to burns.
	Trional; *see* Sulphonethylmethanum						
	Tully's powder; *see* under Morphina						
181	*Tropacocaine hydrochloride (from "small-leaved coca")	al.	sol.	sol.	gr. ¼–1	0.015–0.06	*Local anesthetic:* Similar to cocaine, but less toxic.
	Turpentine; *see* Terebinthina						
90	Ulmus (u. fulva), slippery elm (inner bark)	..	...	...	.....	.....	*Demulcent; Emollient:* As poultice; internally in pharyngitis,
	*Mucilago ulmi	..	...	...	.....	freely	diarrhea, dysentery,
	*Decoction	..	...	...	.....	freely	cystitis, irritation of urinary tract.
	Urotropin; *see* Hexamethylenamina						
251	Uva ursi, bearberry (arctostaphylos u. u., leaves)	..	...	...	ʒ¼–1	1–4	*Astringent; Diuretic:* In chronic disorders of urinary tract.
	Fluidextractum uvæ ursi	..	...	...	fʒ¼–1	1–4	
	Valeriana, valerian (v. officinalis, root)	..	...	...	gr. 10–30	0.60–2	*Stimulant; Antispasmodic:* In hysteria,
	Tinctura valerianæ	..	...	...	fʒ¼–1	1–4	chorea, and other
	Tinctura v. ammoniata	..	...	...	fʒ¼–1	1–4	functional nervous disorders, headaches; in typhoid conditions.
	Vaseline; *see* Petrolatum						
	Veratrina (from sabadilla)	al.	sl. sol.	2.3	gr. $^1/_{30}$–$^1/_{10}$	0.002–0.006	Has been employed externally in neu-
	*Oleatum veratrinæ, 2%	..	...	...	.....	extern.	ralgia and rheumatism, but rarely used
	Unguentum, 4%	..	...	...	.....	extern.	internally.
239	Veratrum viride, Am. hellebore (root)	..	...	...	gr. 1–30	0.06–2	*Sedative:* In action similar to aconite;
	Fluidextractum veratri viridis	..	...	...	♏1–30	0.06–2	in sthenic fevers, mania, puerperal
	Tinctura	..	...	...	♏5–30	0.30–2	convulsions.
	Veronal	ac.	170	v. s.	gr. 5–15	0.30–1	*Hypnotic.*
	Viburnum prunifolium, black haw (bark)	..	...	...	.....	.....	*Tonic; Uterine sedative:* Used to prevent abortion; in
	Extractum viburni prunifolii	..	...	...	gr. 5–15	0.30–1	dysmenorrhea.
	Fluidextractum	..	...	....	fʒ¼–1	1–4	
	Vienna paste; *see* under Potassium						
	*Vinum album, white wine (8.5 to 15% by vol. absolute alcohol)	ac.	...	...	.....	.....	*Stimulant:* Wines depend largely for their medicinal value upon alcohol.

Page in text.	Drug.	Reaction.	Solubility in Water.	Solubility in Alcohol.	Dose.	Dose. Gm. or mil.	Uses.
	*Vinum rubrum, red wine (8.5 to 15% by vol. absolute alcohol)	ac.	...	...	.....	.....	Use same as of vinum album.
	Warburg's tincture; *see* under Quinine						
	Wax; *see* Cera						
	Whiskey; *see* under Alcohol						
	White oak; *see* Quercus						Zinc salts are *astringent*, and in large doses *irritant;* sulphate and acetate are most valuable as *astringents;* in weak solution to inflamed mucous membranes, conjunctivitis urethritis, vaginitis, catarrhs, etc.; in large doses they are *emetic* the sulphate being a mild, efficient and prompt emetic for any age; oxide is used externally as a *sedative* to wounds, ulcers and in diseases of the skin.
	White precipitate; *see* Hydrargyrum ammoniatum						
	Wild cherry; *see* Prunus virginiana						
	Wine, *see* Vinum						
	Wintergreen; *see* Gaultheria						
	Witch-hazel; *see* Hamamelis						
	Wood spirit; *see* Alcohol, methyl						
	Wood tar; *see* Pix						
	Yellow wash; *see* under Hydrargyrum						
	Zincum, zinc, a metal						
	Zinci acetas	N. or sl. ac.	2.3	30	gr. ½–2	0.03–0.12	
80	Zinci chloridum	ac.	0.25	1.3	.....	extern.	Chloride is a powerful *escharotic* and *antiseptic*.
105, 147	Liquor zinci chloridi, 50%						
296							Phosphide and valerate in nervous conditions, hysteria.
106	Zinci iodidum	ac.	v. s.	v. s.	gr. 1–3	0.06–0.20	
106	Zinci oxidum	..	insol.	insol.	gr. 1–5	0.06–0.30	
	Unguentum zinci oxidi, 20%	..	...	...	.....	extern.	Iodide is used mostly as an *alterative* external remedy; may be used in cleaning teeth and in gingivitis.
	Zinci phenolsulphonas	ac.	1.6	1.8	gr. 1–3	0.06–0.18	
	*Zinci phosphidum	....	insol.	insol.	gr. 1/10–1/3	0.006–0.02	
105	Zinci sulphas	ac.	0.6	insol.	gr. ½–2 gr. 10–30	0.03–0.12 0.60–2	*Astringent.* *Emetic.*
251	Zinci valeras	ac.	70	22	gr. ½–3	0.03–0.20	
	Zingiber, ginger (z. officinale, root)	..	...	...	gr. 5–15	0.30–1	*Aromatic stimulant:* Condiment; as *carminative* in flatulence; mild stimulant in atonic indigestion; the syrup as vehicle.
	Fluidextractum zingiberis	..	...	...	♏5–15	0.30–1	
	Syrupus	..	...	...	f℥1–4	4–15	
	Tinctura	..	...	...	f℥¼–1	1–4	
	Oleoresina	..	...	...	♏¼–1	0.015–0.06	

GENERAL INDEX.

Some drugs not listed in the General Index may be found in the Index of Drugs.

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